ORAL SURGERY

A TREATISE ON THE DISEASES, INJURIES AND MALFORMATIONS OF THE MOUTH AND ASSOCIATED PARTS

BY

TRUMAN W. BROPHY

M. D., D. D. S., LL. D., Sc. D., F. A. C. S.

PRESIDENT AND PROFESSOR OF ORAL SURGERY, CHICAGO COLLEGE OF DENTAL SURGERY; PRESIDENT INTERNATIONAL DENTAL FEDERATION; MEMBER AMERICAN MEDICAL ASSOCIATION, ILLINOIS MEDICAL SOCIETY, CHICAGO MEDICAL AND DENTAL SOCIETIES, ILLINOIS STATE DENTAL SOCIETY NATIONAL DENTAL ASSOCIATION; HONORARY MEMBER OF ALL NATIONAL DENTAL ASSOCIATIONS OF CONTINENTAL EUROPE, NORTH AMERICA AND SEVERAL OTHER COUNTRIES; MEDALLIST ODONTOLOGICAL SOCIETIES OF PARIS AND ITALY, AND OF NEW YORK STATE DENTAL SOCIETY; ORDER OF OFFICER OF PUBLIC INSTRUCTION BY THE FRENCH REPUBLIC; ORAL SURGEON TO ST. JOSEPH S, MICHAEL REESE AND OTHER CHICAGO HOSPITALS; CONSULTING ORAL SURGEON PRESBYTERIAN HOSPITAL, ETC.

WITH SPECIAL CHAPTERS BY

MATTHEW H. CRYER, M. D., G. HUDSON MAKUEN, M. D.
WILLIAM J. YOUNGER, M. D., F. W. BELKNAP, M. D.
CALVIN S. CASE, M. D., D. D. S.

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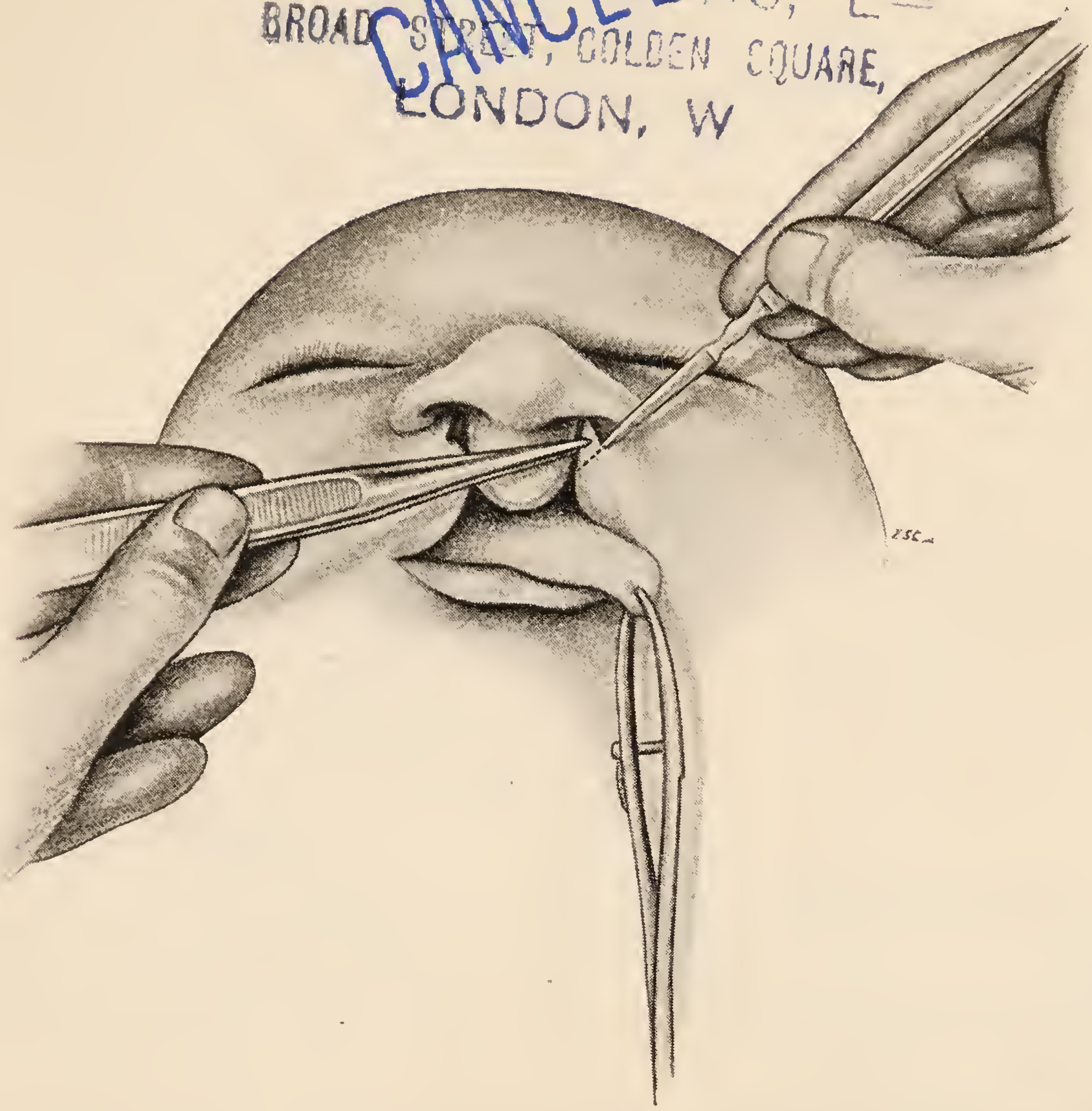


FIG. 284.—Incision used in correcting flattened nose in single or double harelip operations.

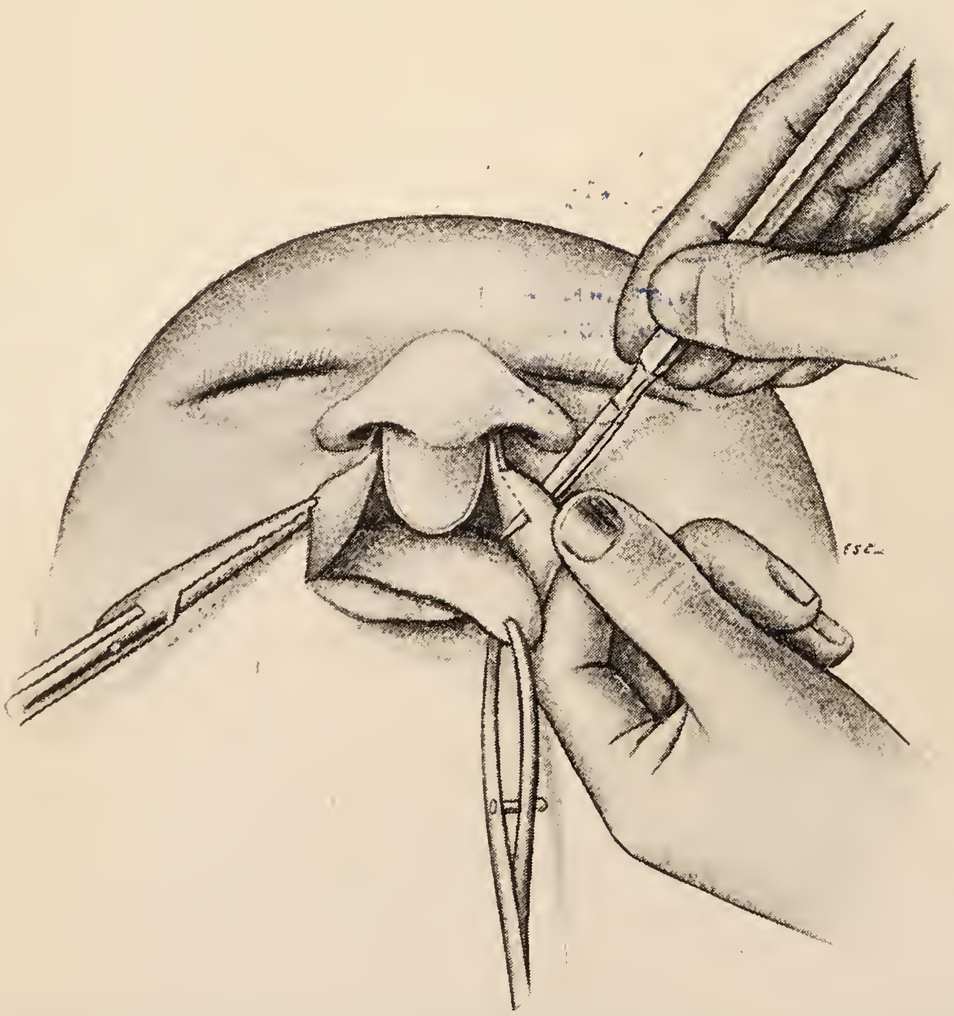


FIG. 285.—Proper position to hold knife in making flap. The mucous surface is shown here.

incision is made then through the substance of the lip upward and inward to the lower terminal point of the nostril incision (Fig. 285). The knife should be directed through the lip so as to bring downward a much broader surface of mucous membrane than skin. This is done for the purpose of rolling out the middle portion of the mucous membrane to give the lip the proper fullness after union has taken place in the median line. The end of the flap is seized with forceps and held by the assistant while the operator controls the hemorrhage with hemostatic forceps. The forceps are allowed to remain on the flaps until nearly all the sutures are placed and tied.

Second Step.—The opposite side is treated in the same manner; the vessels are taken up promptly as soon as exposed. If there is considerable

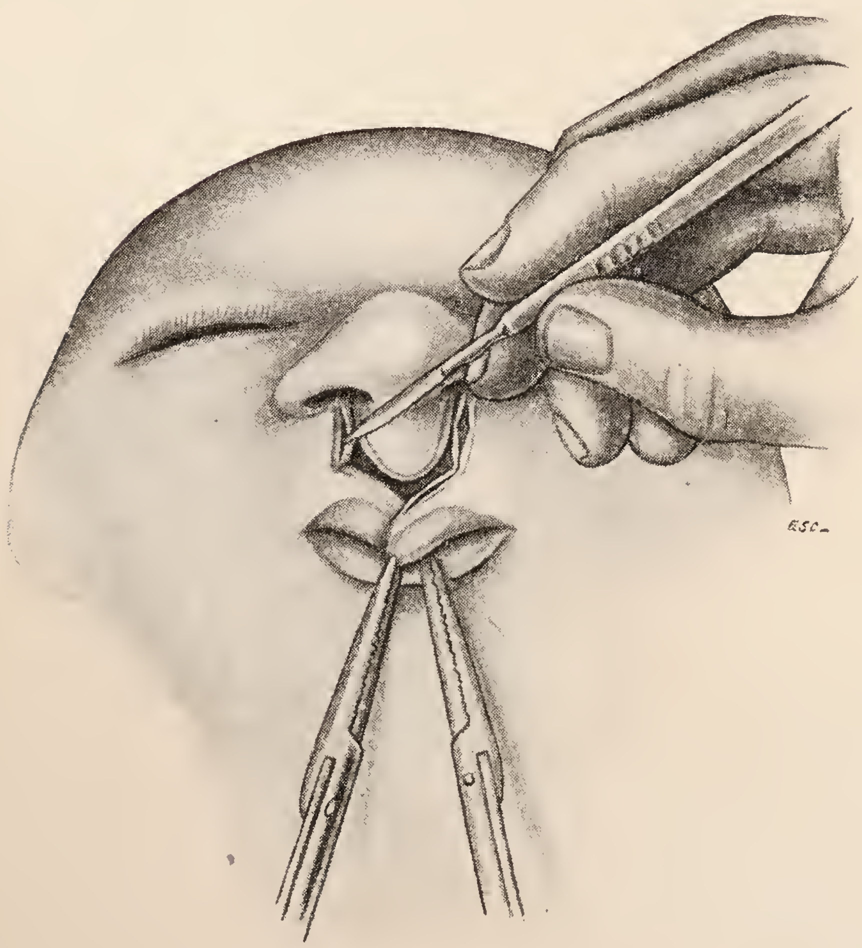


Fig. 286.—Flaps held in position by forceps. The freshened surfaces have been split, so as to avoid the formation of grooves in the skin.

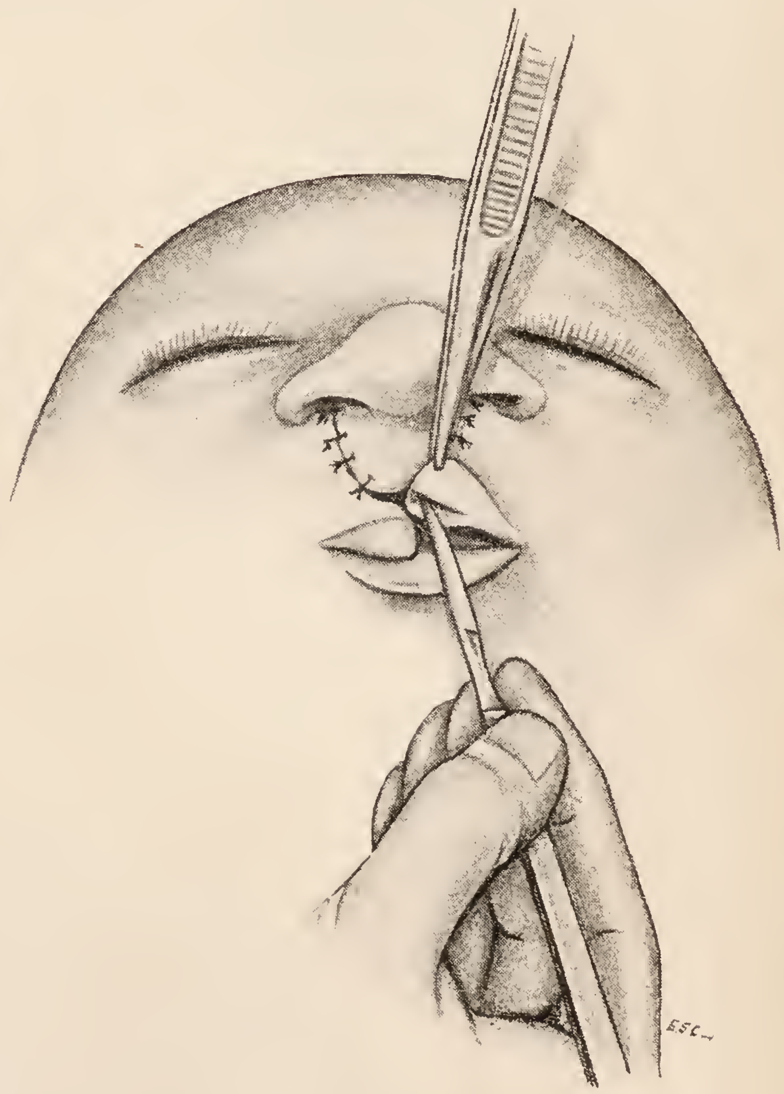


Fig. 287.—Incision used to give proper fulness to the center of the lip.

oozing, adrenalin chloride, one part to 10,000, may be employed to advantage. I do not use this unless the hemorrhage is considerable, for reasons previously given, page 519. In order to prevent the groove forming from the nostril downward after the parts are sutured, the central part of the lip, as well as all of the lateral freshened surfaces, should be split so that the skin and mucous membrane may be more widely separated (Figs. 286 and 287.

Third Step.—We now have the surfaces all freshened, ready for suturing. To facilitate this and the approximation of the edges of the fissures, a strong

silk suture is carried into the mouth, through the muscular tissue almost to the skin, including both sides of the fissure, and just through the tip of the

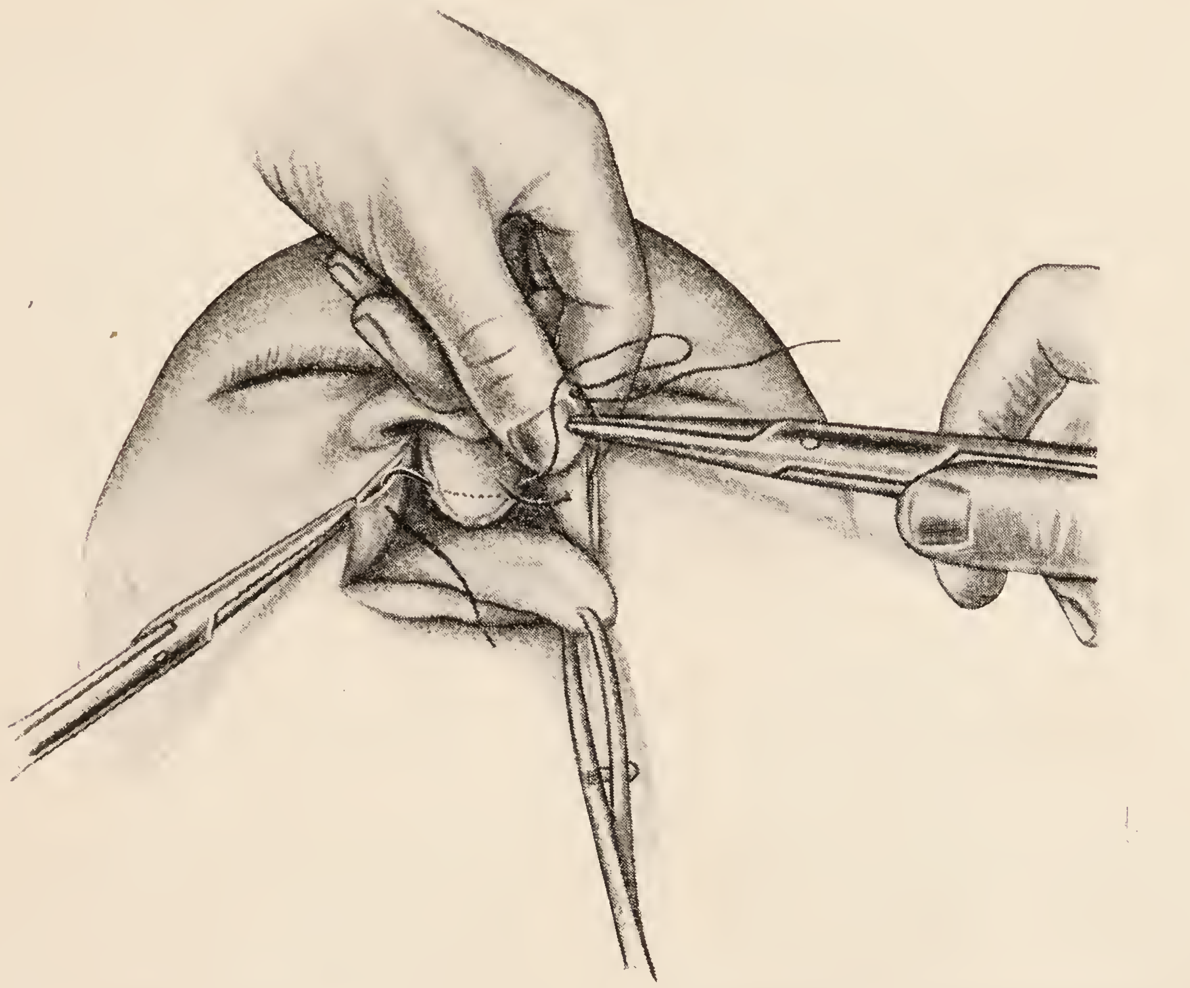


FIG. 288.—Temporary suture used to draw separated tissues together.

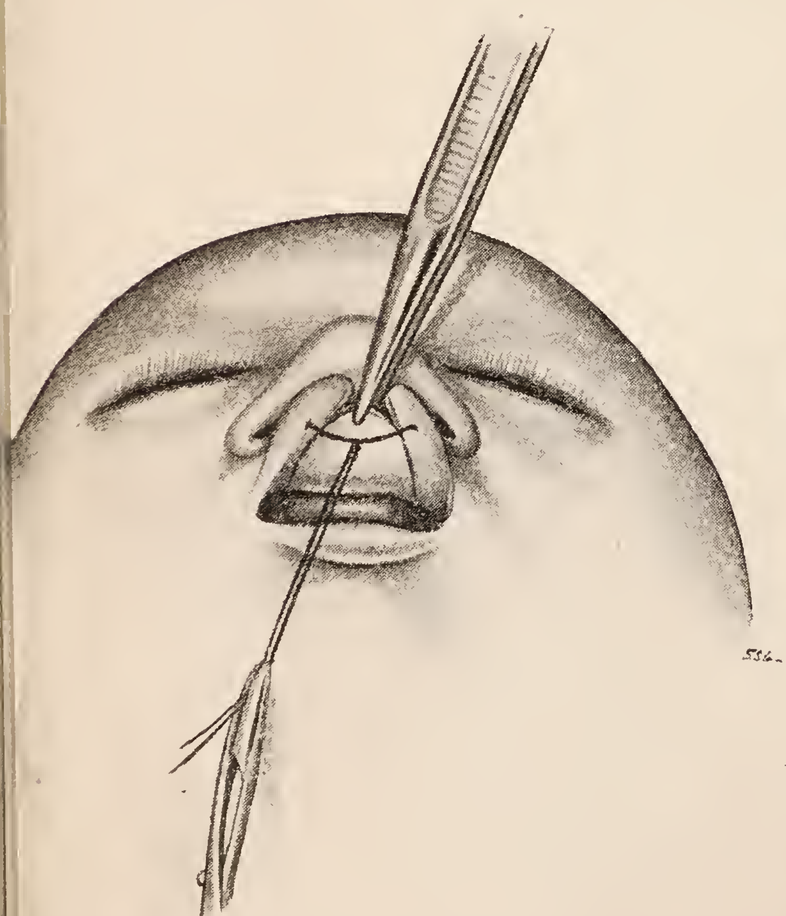


FIG. 289.—Temporary suture tied and separated tissues brought in contact.

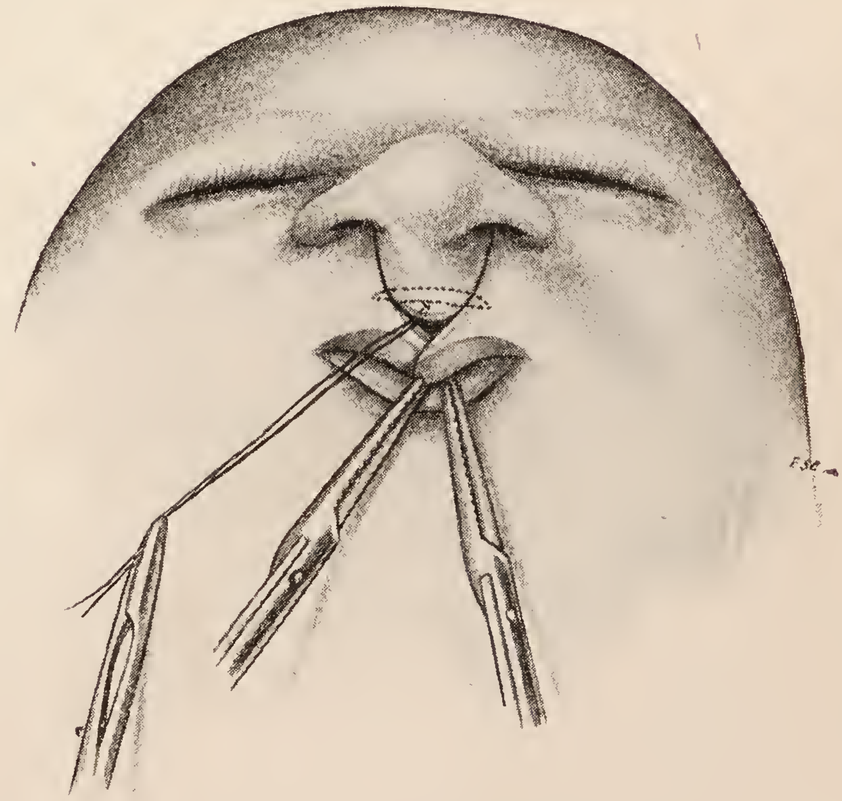


FIG. 290.—Skin surface of lip showing tissues brought in contact and temporary suture beneath (dotted lines).

central portion of the lip (Fig. 288). The suture is drawn up by means of the surgeon's friction knot and the separated tissues brought in contact (Fig. 289).

We do not secure the knot, since we may wish to change it in further development, but the double turn of the knot will hold it quite satisfactorily until the

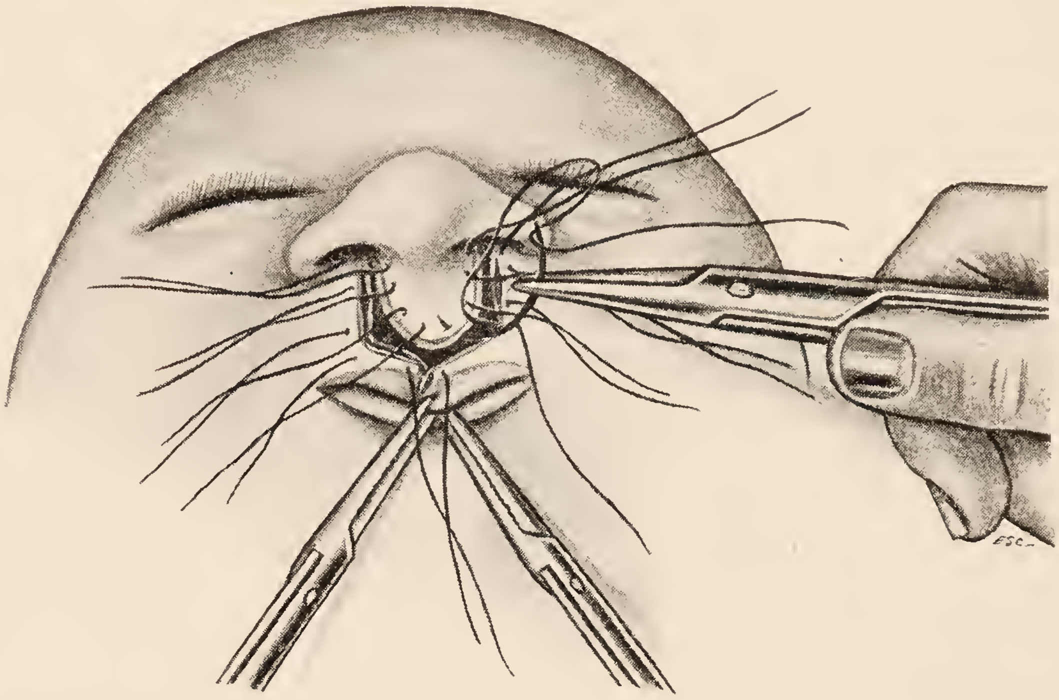


FIG. 291.—Method of introducing interrupted horse-hair sutures. Small hemostatic forceps used to secure correct relation of edges of the lip.

horse-hair sutures are adjusted (Fig. 290). Should the knot slip, we may hold it firmly by seizing it with forceps. Now we remove the plugs from the nostrils and introduce a silk suture on a small, curved Hagedorn needle well

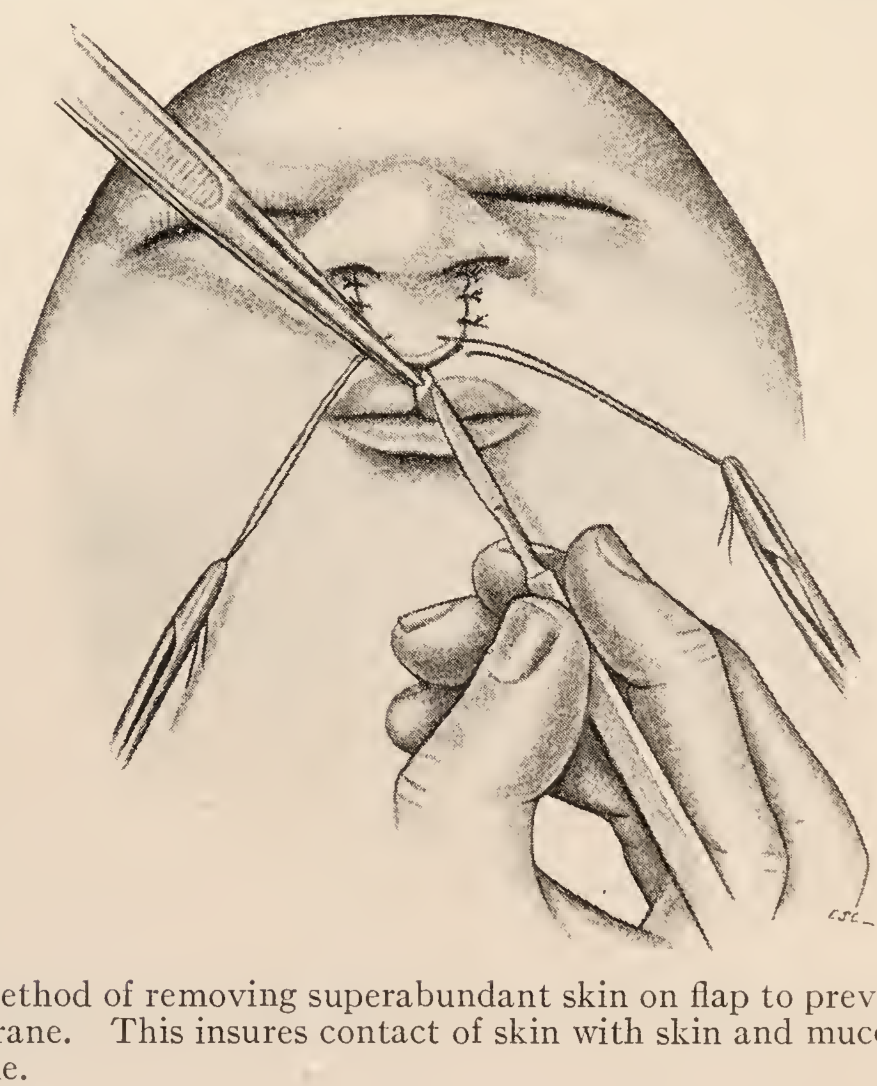


FIG. 292.—Method of removing superabundant skin on flap to prevent the overlapping of mucous membrane. This insures contact of skin with skin and mucous membrane with mucous membrane.

up into the nostril, including all the tissues freshened except the inner mucous membrane. Only the first turn of the surgeon's knot is made; the

tail ends of the sutures are grasped with hemostatic forceps, and interrupted horse-hair sutures are introduced down to the terminus of the central portion of the lip. Only one turn of the knot is made until all the sutures on both sides are inserted to this point. The angle of the incision is brought in contact with the central part of the lip by introducing sutures, as shown in Fig. 291, and carried into the substance of the central part of the lip. This is repeated on the opposite side. The part below the central portion is then sutured. At this point we stop and tie all sutures beginning at the nose.

Fourth Step.—We have still one of the most interesting and important steps to take in producing a correct vermilion border of the lip. This requires a great deal of painstaking effort. The flaps brought down are sufficient in quantity to produce a most beautiful cosmetic result, but the most common error of the operator is in making the lip too long. The mistake lies in fail-

FIG. 293.—Method of joining mucous membrane in the mouth.

ing to manipulate the tissues in such a way as to prevent the formation of a notch in the median line after the parts are united.

It is necessary to take into consideration the fact that a superabundance of skin has been brought down to the median line. Some of it must be removed to prevent the skin running into the mucous membrane, thus disfiguring the lip (Fig. 292). Having removed enough of the skin to avoid its over-lapping the mucous membrane, the needle is inserted into the skin at the border of the membrane and carried through the tissues of the opposite side, with an exit corresponding exactly to the point of entrance of the needle. The sutures are put in in sufficient numbers to secure perfect coaptation of the tissues. Only the first knot is tied so that necessary changes may be made easily. We are certain now of bringing skin in contact with skin only and mucous membrane in contact with mucous membrane.

The sutures in the skin are left. The mucous membrane and inner part of the lip remain to be sutured later. That portion of the tissues, which has been within the grip of the beaks of the hemostatic forceps, which includes a very little, should be cut off since it has been crushed by the forceps and is of no value.

Fifth Step.—Then the center of the lip, the most pendant part, is sutured with horse-hair, a few sutures are inserted on the under portion of the lip within the mouth (Fig. 293), and the operation is complete (Fig. 294). The error of making the lip too long is due to having, in the first place, a long central portion with large flaps added to its lower part. The central portion should be made short enough to give it, after the flaps have been adjusted, the correct length. Two things, therefore, must be considered: First, the length

Fig. 294.—All sutures have been placed and the operation is completed. It still remains necessary to adjust the tension straps (see Fig. 279.)

of the central portion; second, the size of the flaps to give the lip its proper length. To relieve the strain upon the stitches and to prevent them from cutting out and allowing the parts to separate, the retention straps before described (Fig. 279) should be employed. They can be relied upon to hold the parts in contact until union takes place.

COMPLICATED DOUBLE HARELIP

General Considerations.—This form of double harelip may be complicated by the premaxillary bones extending forward, which, in some instances, carries the central part of the lip far beyond the end of the nose (Fig. 249).

In such a complication, the double fissure in the lip is usually complete, though occasionally there may be a band of integument connecting one side

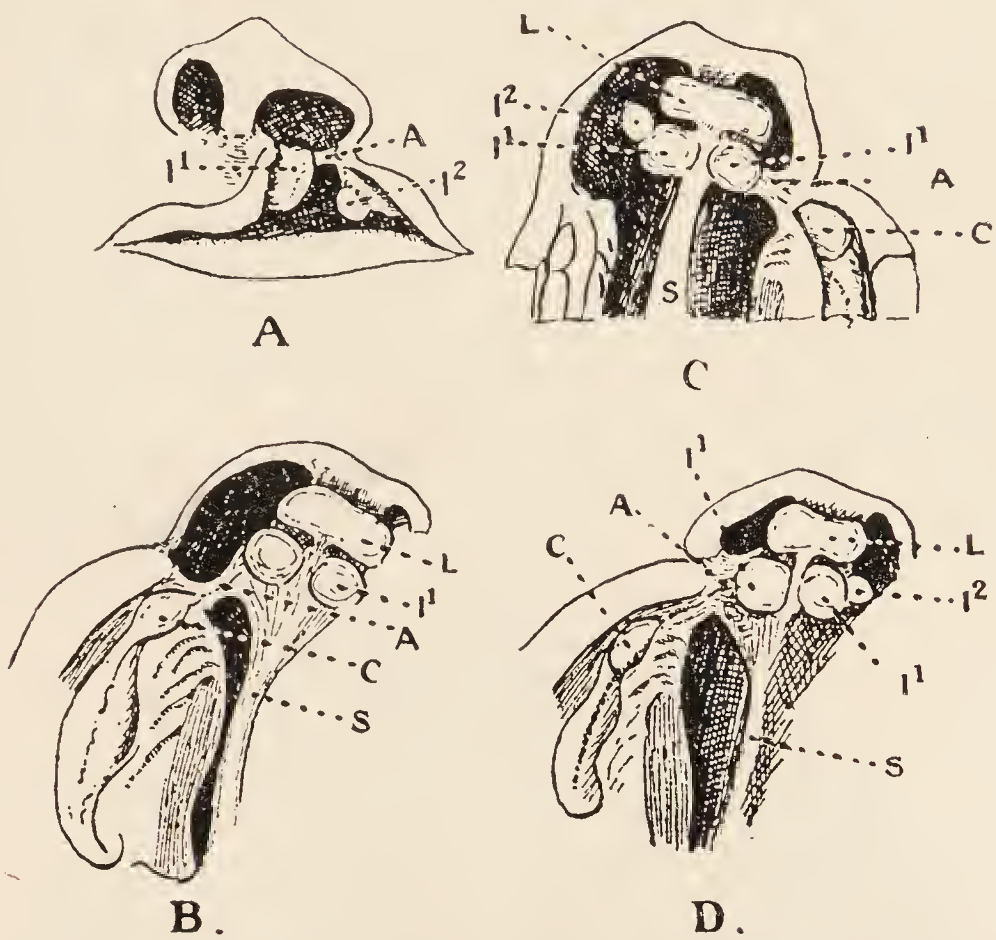


Fig. 295.—Four specimens of cleft palate showing various degrees in the development of the bond between the premaxillary, maxillary and lateral nasal elements. *A*, The bond or bridge of tissue crossing the cleft. l^1. Central incisor sac; l^2Lateral incisor sac; *C*, Canine sac; *L*, Median part of upper lip; *S*, Septum of nose. (*Keith.*)

of it with the median line (Fig. 295). The management of this deformity requires the bringing of the premaxillary bones in proper position by removing

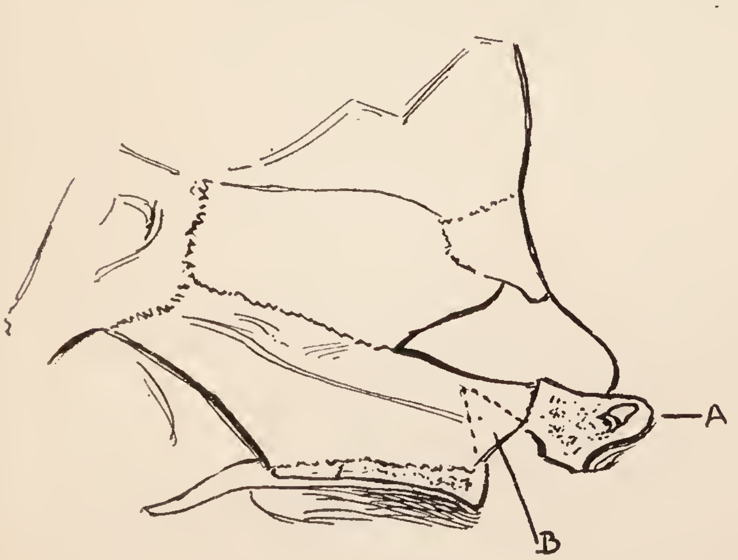


Fig. 296.

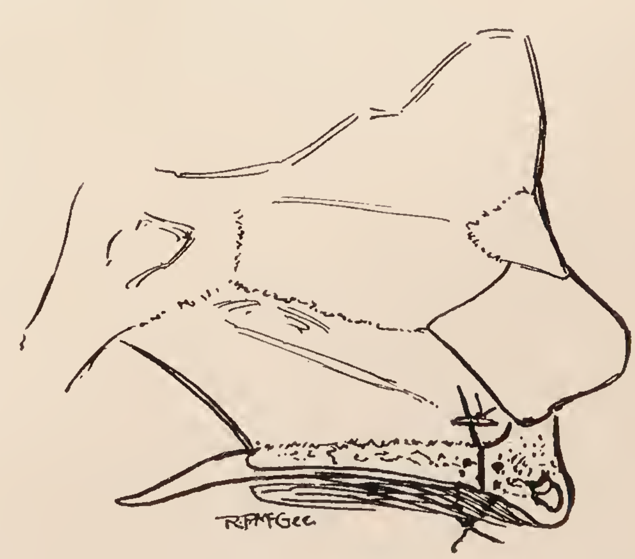


Fig. 297.

Fig. 296 and 297.—Vertical section of palate nasal region of a child nine weeks of age, showing cleft palate and bilateral harelip, and protrusion of the premaxillæ. Protruding bones placed in their proper position and held by silver sutures. Germs of the incisors undisturbed. *a*, Protruding premaxillary bones containing germs of temporary central incisors. *b*, *V*-shaped incision in the vomer, indicated by dotted lines.

a V-shaped piece from the vomer (Figs. 296 and 297), or, what is better, the making of an oblique incision through the vomer, carrying the prominent

premaxillary bone back into position, as described on page 678 in Cleft Palate, and fixing it there by means of silver sutures (Fig. 484). The writings upon this subject, which express disapproval of wiring the premaxillary bones to the maxillæ, are, I believe, from the pens of authors of limited experience in the treatment of these congenital defects or, possibly, from those unfamiliar with the technic required to establish a solid, bony arch by bringing the premaxillary bones into the position where they belong. Once placed in proper relation with the maxillary bones, freshened and firmly wired together, a solid bony arch will be secured. Those operators who have failed to secure a union of the parts in these cases have lacked in their technic.

The vomer may be split from the premaxillary bones backward about 2 cm. (Fig. 298). By pressing backward on the premaxillary bones the split

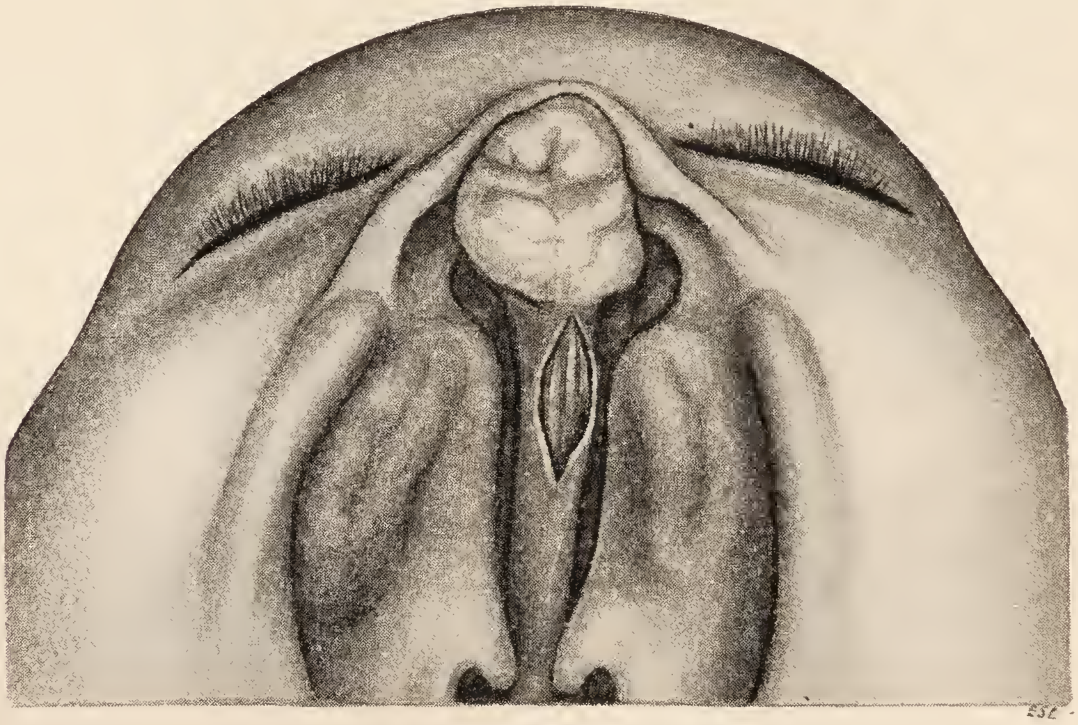


FIG. 298.—Shows the method of splitting the vomer so as to move the premaxillary bones backward. (*Bardeleben.*)

portions of the vomer spread. This permits the premaxillary bones to come in contact with the maxillary bones.

Operation.—The method of procedure in the closure of bilateral harelip, after union of the malposed vomer and the premaxillary bones has been secured, does not differ in any sense from the operation for simple bilateral harelip. The adhesive straps applied to the face with sutures extending over the lip from one strap to the other (Fig. 279) hold the parts firmly in position and prevent them from separating. Moreover, the wound may be kept absolutely clean.

The nose may be plugged with gauze, if thought best, to prevent the exit of secretions upon the wound or, what is quite as good, we may wipe the parts frequently with applicators and thus keep the surfaces clean and dry. These plugs should not remain longer than three days. The patient's hands should be so fixed that he cannot disturb the parts (Fig. 353).

Some operators make use of rubber tubing for draining the nose. Frequently the secretions escape around the tube thus defeating its purpose.

COMPLICATIONS FOLLOWING DOUBLE HARELIP OPERATIONS

Nose Defects.—The retention straps, lashed together, are permitted to remain for a week, when they and all the sutures are removed. In some cases a twenty per cent. solution of argyrol may be used on the under surfaces of the lip as a prophylactic measure against infection. However, infection of the lip is not at all likely to occur if the precautions here outlined are observed carefully. It will be seen, following nearly all operations for double harelip, especially when the premaxillary bones are prominent and require moving back into position, that when union of the parts has taken place and

FIG. 299.—First step in operation for elevating the flattened nose.

the sutures and adhesive straps are removed, the nose is flattened somewhat, having been drawn inward by the central portion of the lip (Figs. 306, 308 and 310). To overcome this defect, which is very great sometimes, I devised an operation for lifting the end of the nose and carrying it out to a normal position.

Flattened Nose Operation.—First Step.—This operation is made by starting an incision at the anterior extremity of the medial crus of the great alar cartilage of the nose and carrying it posteriorly between this cartilage and the anterior nasal spine of the maxilla, thence downward into the substance of the lip about two-thirds of its length (Fig. 299). A corresponding incision is made on the opposite side, always keeping close to the medial wall

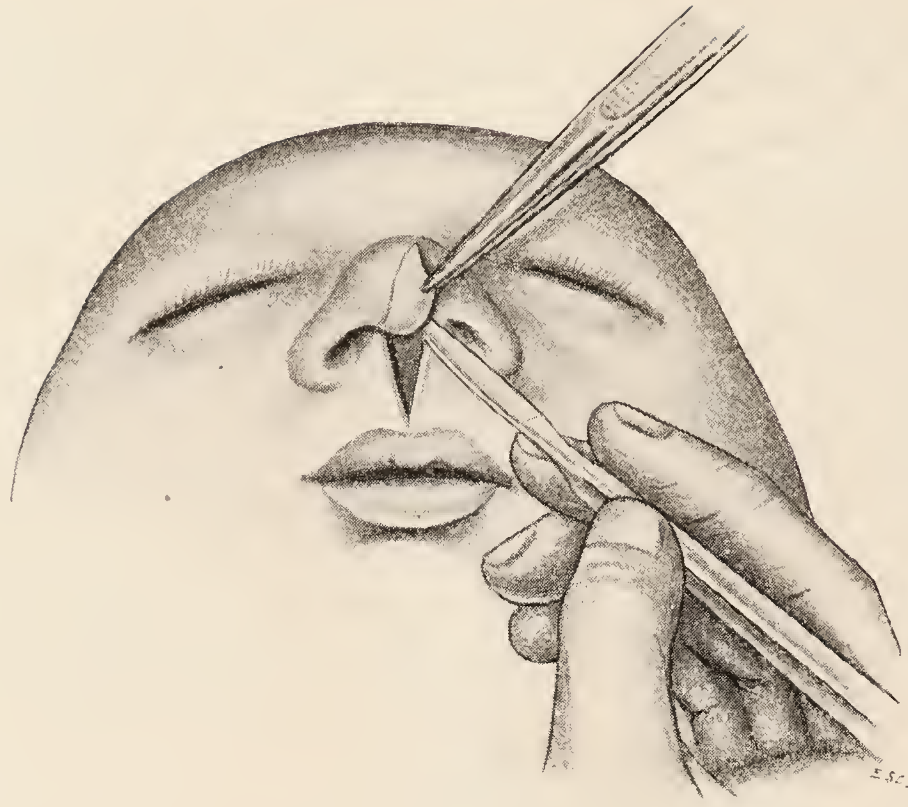


FIG. 300.—Elevating the tissues by dissection, care being taken not to pass the knife through the mucous membrane.

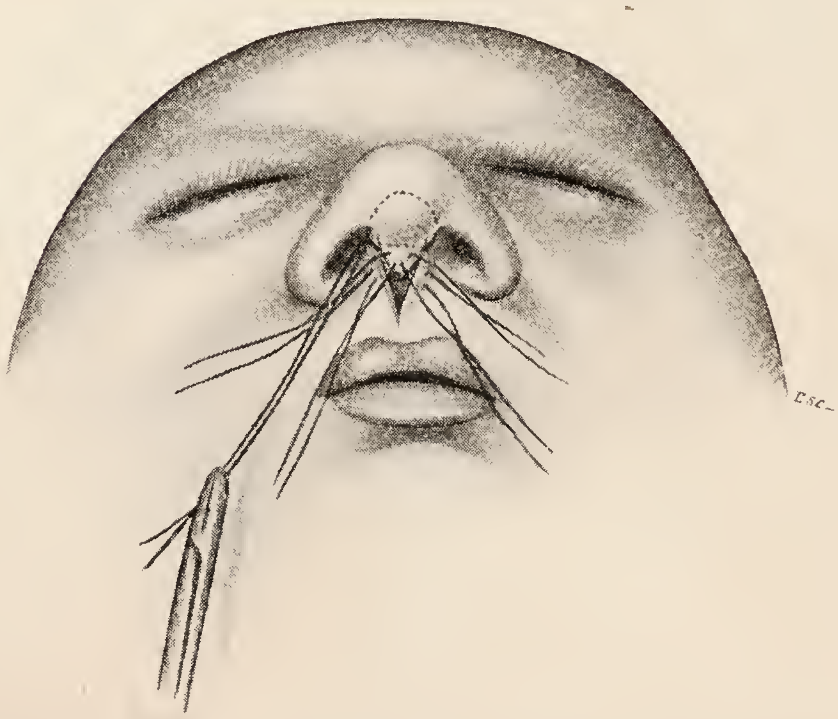


FIG. 301.—Dotted lines show the course of silk suture through the cartilage of the nose beneath the skin. On tying, the suture lifts the end of the nose forward thus removing the flattened appearance and giving the nose the proper form (see Figs. 307 to 309).

FIG. 302.—The end of the nose has been raised and the sutures are placed to approximate the edges of the wound in the lip.

of the nostril, but not penetrating it. This long V-shaped incision should be deep enough to include, in the part to be lifted up, muscular tissue extending half-way through the lip. The tissue should be raised from the central

Fig. 303.—Front view of girl eleven years old with an extensive deformity of the nose, lip and palate with protrusion of the premaxillary bones.

Fig. 304.—Front view showing double harelip.

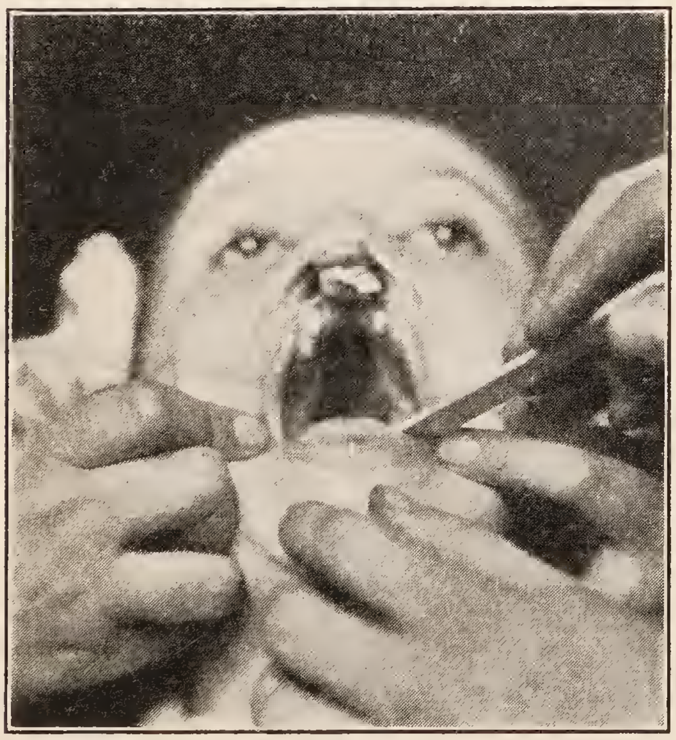


Fig. 305.—Complete cleft of the palate. The premaxillary bones are separated from and protrude beyond the maxillæ.

Fig. 306.—Same patient after operation showing the cleft in palate closed, the premaxillary bone in normal position and the harelip united.

part of the lip and a careful dissection made of the covering of the nasal septal cartilage, when the entire mass should be lifted upward, exposing to view the anterior extremity of this cartilage (Fig. 300).

Second Step.—A black silk suture is passed through the end of the cartilage and through the uplifted flap in such a way as to force the mass

of tissue forward (Fig. 301). As the silk suture should be removed in six days, it is better to use black since this is more easily seen. The lateral crus of the greater alar cartilages is carried forward at once and the point of the nose raised to the desired extent. Having fixed the point of the nose by suturing through the cartilage and soft parts, the opening made in the

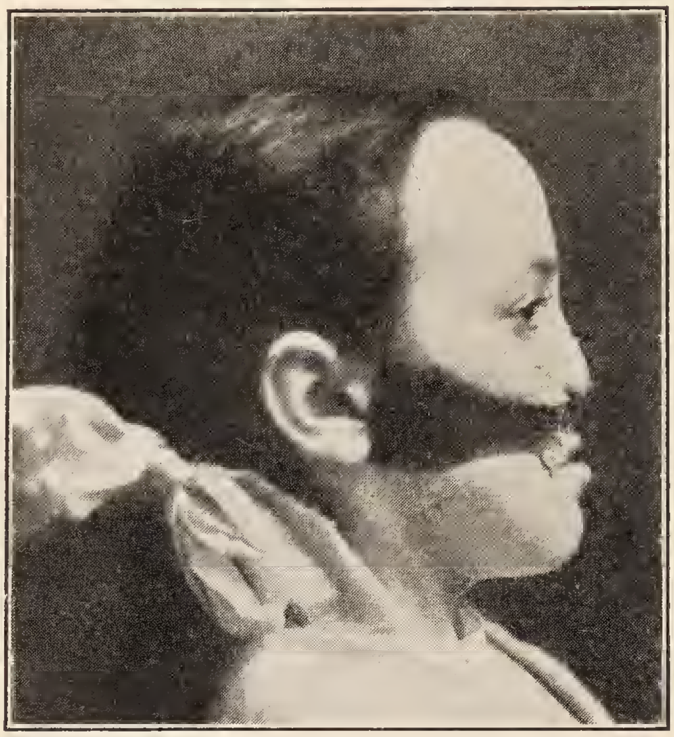


FIG. 307.—Tension straps used following closure of the lip.

FIG. 308.—Profile showing the flattened nose which could not be prevented when the protruding premaxillary bones were brought in contact with the maxillæ.

FIG. 309.—Nose elevated after previous operations have been completed.

FIG. 310.—Front view of patient showing flattened nose.

lip may be closed quickly by two or three interrupted horse-hair sutures (Fig. 302).

The series of pictures shown in Figs. 303 to 311 demonstrate a case complicated by protrusion of the premaxillary bones and complete cleft

of the hard and soft palates. The results of the operations previously described are here well shown.

Contraction and Recession of Lip.—The practice, which, unfortunately, has been resorted to not infrequently, of excising the premaxillary bones and closing the fissure of the lip invariably leads to a contraction and recession

FIG. 311.—Front view after all operations have been completed.

FIGS. 312 and 313.—Result following the excision of the premaxillary bones. Note contraction of upper lip and protrusion of the lower, profile view.

of the lip, followed by a most conspicuous deformity (Figs. 312 and 313). Sometimes the lip is greatly contracted, though the premaxillary bones are not removed (Fig. 314). The upper lip contraction gives to the lower lip a greater relative prominence and thickness than it would have had if the pre-

maxillary bones had been preserved and the lip united over them. The excessive development of the lower lip is due to failure of direct occlusion with the upper lip and to over-lapping. Extensive contraction and recession of the upper lip, with a corresponding protrusion of the lower lip, require plastic operations for their relief (Fig. 315). Frequently these cases present a mass of cicatricial tissue which needs to be removed for the cosmetic effect.

Operation.—First Step.—Here, as in other forms of plastic surgery, several steps are necessary to accomplish the end desired. First among these

FIG. 314.—Badly operated lip. V-shaped piece removed from lower lip and upper lip projected by folding the mucosa forward.

is the preparation of the patient for operation and a thorough understanding of his physical condition. A study of the parts impresses the surgeon with the unequal size of the two lips (Fig. 316). It will readily be seen that if the tissue in the two were equalized, the patient's mouth would be restored to an approximately normal condition. With this end in view, I utilize the superabundant tissue of the lower lip and add it to the insufficient upper lip to relieve the tense and contracted condition. To remove from the lower lip a portion of the tissue and add it to the upper lip corrects the deformity. They are equal in size now and symmetrical. Careful measure-

FIG. 315.—After operation.

FIG. 316.—Profile view of patient whose protruding premaxillary bones had been removed in early infancy. The palate posteriorly was normal. This view shows the recession of upper lip.

FIG. 317.—Upper contracted lip split in the center for the reception of V-shaped piece from the lower lip.

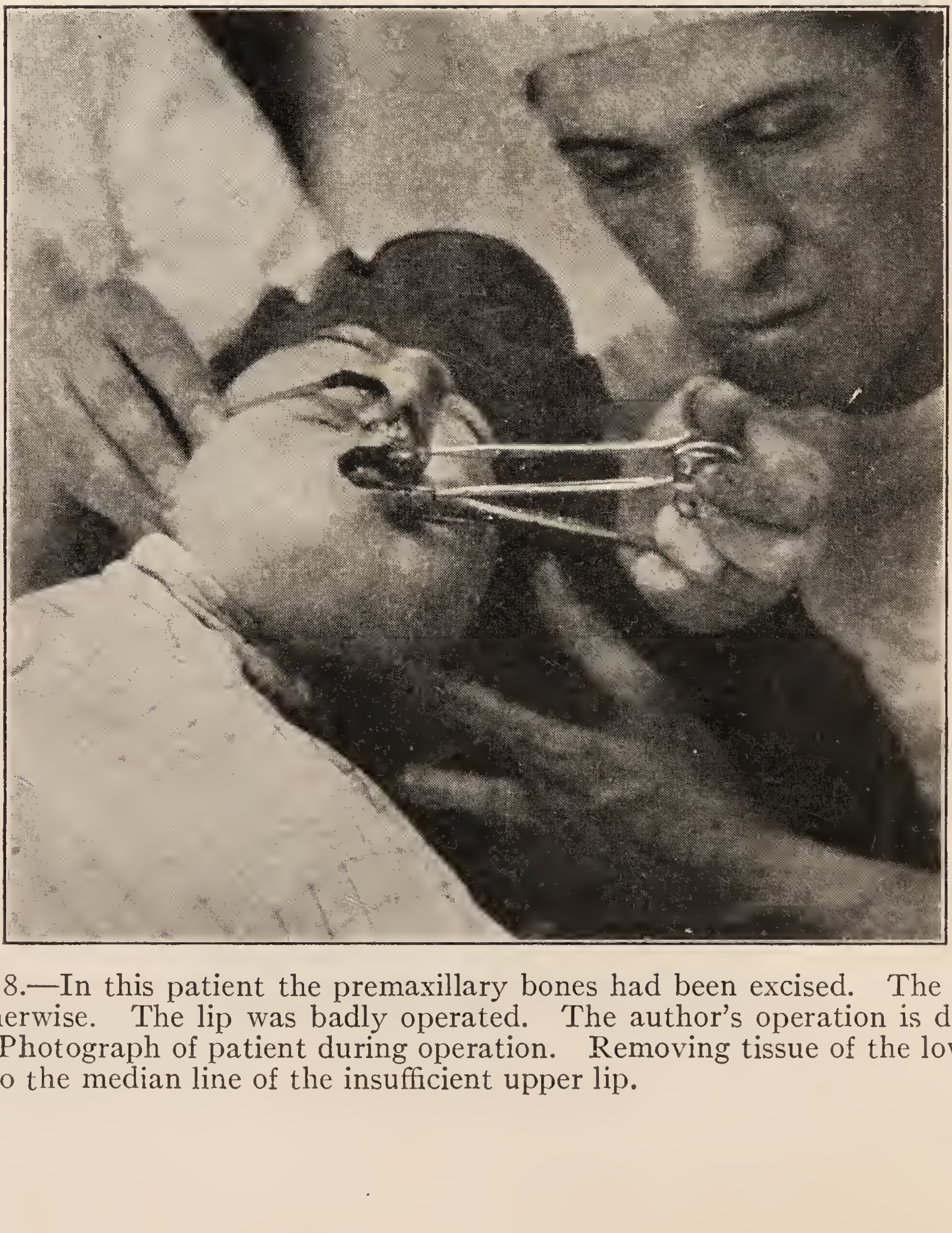


FIG. 318.—In this patient the premaxillary bones had been excised. The palate was normal otherwise. The lip was badly operated. The author's operation is described in the text. Photograph of patient during operation. Removing tissue of the lower lip and uniting it to the median line of the insufficient upper lip.

ment of the two lips enables the surgeon to decide how much tissue it is necessary to take from the lower lip and add to the upper in order to make the two equal.

FIG. 319.—Flap from lower lip placed in upper lip. Flap still attached to lower lip.

FIG. 320.—The graft from the lower lip has been united in its new position in upper lip. The mouth is too small.

FIG. 321.

FIG. 322.—Mouth made larger by incising the angles.

Second Step.—Division of the upper lip, by making incision through its thickness in the median line, is the second step to take (Fig. 317) following which, after hemorrhage is controlled, an incision is made in the lower lip so as to secure a V-shaped flap to be inserted in the upper lip (Fig. 318). Beginning at the left of the center, carry the incision obliquely downward

to the median line of the lower lip, then upward toward a point corresponding to the place of beginning. This upward incision should not be carried more than half-way from the apex of the V to the mucous membrane of the lip. This liberal attachment will secure good circulation to the flap. After hemorrhage has been controlled, this piece may be inverted, *i.e.*, the apex

FIG. 323.—Profile view after operation.

FIG. 324.—Front view before operation.

FIG. 325.—Front view after operation.

may reach up into the split upper lip and be secured there by sutures (Fig. 319). Strong silk sutures are passed through the mucous membrane, embracing a great part of the muscular tissue of the right side of the lower lip, and carried into the upper lip so they are closely and firmly sewed to each other. The object of this is to prevent separation of the lips and the possibility of

preventing union of the flap in its new position. These stitches are temporary only, to be used until union of the flap from the lower lip to the upper has become thoroughly established.

FIG. 326.

FIG. 327.

FIG. 328.

FIG. 329.

FIGS. 326 to 329.—Harelip and cleft palate in patient thirty-five years of age. He had been operated at one and seven years of age. Operated a third time, by the author, with the result shown.

The freshened surfaces of the right side of the lower lip may be closed over by suturing the mucous membrane to the skin. This protects them from exposure and the formation of granulations. With the parts in position,

the patient's under jaw may be secured by applying Barton's bandage. A substantial union of the flap with the right side of the upper lip should be accomplished in about two weeks when good circulation shall have been established. There is sufficient room between the lips at the left corner of the mouth to feed the patient by means of a tube.

FIG. 330.—Photograph of plaster model of patient shown in Figs. 326 to 329. *A*, Before operation; *B*, after operation.

FIG. 331.—The premaxillary bone extends to the end of the nose.

Third Step.—The next step will be to complete the upward incision of the right side of the lower lip and release the flap from its attachment. Then swing it over to the left side where the membrane and skin have been brought in contact, separate the skin from the mucous membrane, scarify the surfaces so as to leave them freshened and suture the flap into place, being careful to have mucous membrane meet mucous membrane and skin meet skin. This done, attention should be given promptly to the lower lip by freshening the edges of the wound and suturing them.

FIG. 332.—Same case as 331 after operation. Six months old.

FIG. 333.

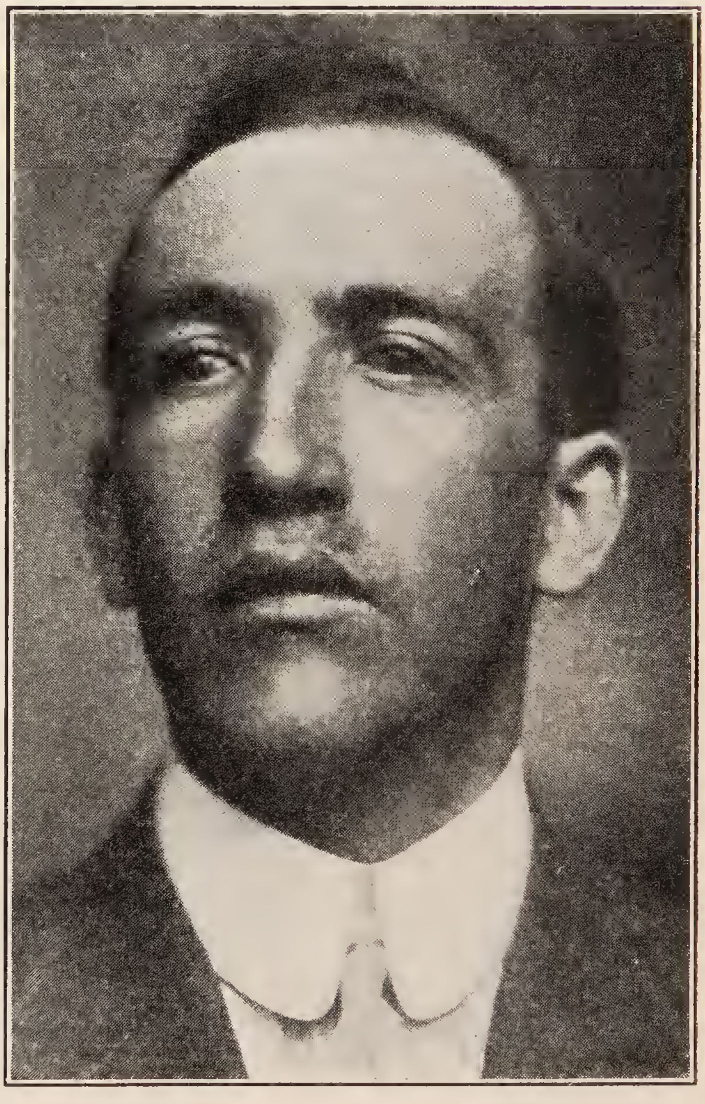


FIG. 334.

FIGS. 333 and 334.—Deep notch in the lip before and after operation.

Secondary Operations.—After union has occurred, the two lips will be of about equal length and thickness. If the premaxillary bones have been excised, the upper lip will still recede to some extent, but with the adjustment of artificial teeth, what little depression is left, following the operation, will be overcome and the lip brought into correct prominence. Care should

FIG. 335.—Infant three months old, with complete double harelip.

FIG. 336.—Same patient at eighteen months of age.

FIG. 337.—Harelip and cleft palate in infant. An incisor tooth is attached to a pedicle of mucous membrane quite independent of bone (left side of patient).

be taken that the under side of the lip is sutured so that mucous membrane will meet only mucous membrane. It is better to have the freshened surfaces under the lip closed. This may always be done by covering them with the mucosa. After the parts are united, sufficient time should be allowed for them to become fixed in their new position, with a good circulation established, when other steps called for may be taken. These may include the removal of scar tissue, adjustment of the alæ of the nose, if required, and,

still later, the study of the mouth, which, following the operation, is sometimes too small (Fig. 320). To increase its size, incisions should be made

FIG. 338.—Same patient one year later.

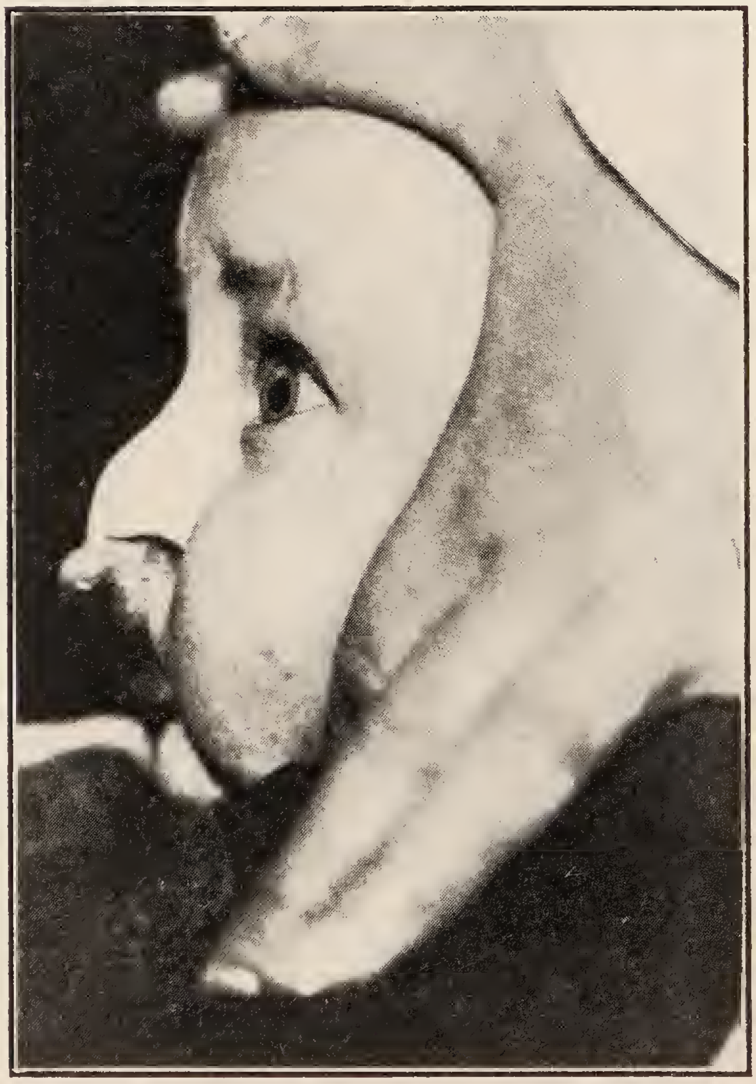


FIG. 339.—Double harelip, complicated with protruding premaxillary bones. No cleft of palate.

at each angle, carried backward, and the mucous membrane and skin approximated (Figs. 320 to 325). Time should be allowed for union to take place and a few weeks later the patient should return for any other operation

that may be called for to improve the parts. Figs. 326 to 352 show a number of patients operated on by me.

FIG. 340.—Harelip complete on the left side, partial on the right, with protruding premaxillary bones and cleft palate.

FIG. 341.—Double harelip showing premaxillary bone, extending to the end of the nose.

POST-OPERATIVE TREATMENT

The post-operative treatment of harelip, which has been looked upon in the past with so much uncertainty as to securing a good result, I regard, with the present facilities for retention, as not only simple but reliable. With horse-hair sutures only, with no pins, clamps, wires, buttons, adhesive straps

across the face, or other cumbersome and unnecessary appliances, we may expect to secure a smooth, well-formed lip, free from notches and scars. In single harelip operations, the nostril will nearly, or quite, conform in size and

FIG. 342.

FIG. 343.

FIG. 344.

FIG. 345.

shape to the normal one; in double harelip, the two nostrils may be so constructed that they will be exactly alike.

Before the patient has recovered from the anesthetic, the application of adhesive strips, laced from side to side, will hold the tissues together until union may take place with the greatest comfort possible to attain in the

management of such cases. Should mucus escape from the nose in considerable quantity, sufficient to cover the newly approximated parts continu-

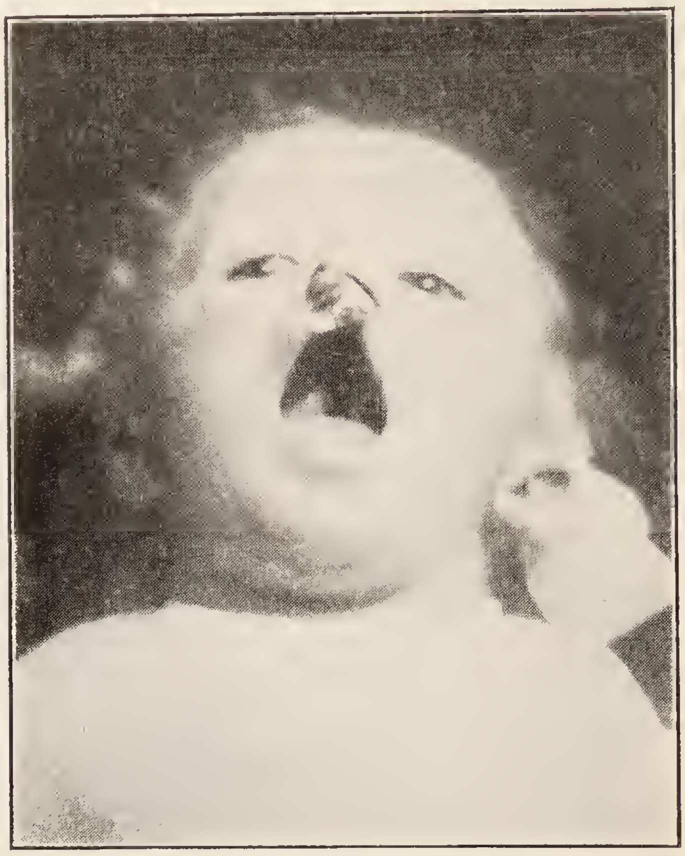


Fig. 346.

Fig. 347.

Figs. 342 to 347.—Double harelip, protruding premaxillary bones and cleft palate in a child four years old. Before and after operation.

Fig. 348.—Front view of patient with a probe in hole in median line of upper lip which had previously been operated. There is a complete cleft of hard and soft palates.

Fig. 349.—Same after operation.

ously, the nose may be plugged with antiseptic gauze and the secretions thus prevented from escaping. The surface of the lip should be kept abso-

lutely clean, which may be accomplished by carrying an applicator saturated with boric acid solution beneath the strands of silk which hold the adhesive strips in place, and all secretions and moisture thus removed. The under

FIG. 350.—Profile of same patient before operation.

FIG. 351.—After operation.

FIG. 352.—Deep sinuses extending into the lips marked by toothpicks. They extend three-quarters of an inch into the tissues. These sinuses correspond to the position of the separated part in double harelip.

surface of the lip should be irrigated and then dried as well as can be by the use of applicators, then touched over with a twenty per cent. solution of argyrol as a prophylactic measure.

Infections of the lip should not occur. It is presumed that, prior to the operation, the surface of the lip has been made as nearly antiseptically clean as possible. If so, and the parts are kept clean following the operation, infection is not at all likely to occur. Should infection take place, the parts must be thoroughly flushed, dried and saturated with a twenty per cent. solution of argyrol. If the infection does not clear up promptly, pure

Fig. 353.—Showing the author's cuffs properly placed. This child was operated for single harelip and cleft palate.

tincture of iodin should be used. The danger of the child handling and interfering with the lip is overcome completely by constructing the long pasteboard cuffs illustrated in Fig. 353, which extend from the hand to a point midway between the elbow and the shoulder. With these constructed of proper size, the child has unlimited motion of the shoulder, hand and fingers, but it is impossible for him to bring his hand to his mouth. The opthalmologist finds them of equal value in keeping the fingers from the eyes.

MORTALITY RATE TABLE

Age	Operation	Deaths	Last cases*	Deaths
1 month	103	24	9	0
2 months	136	21	9	0
3 months	159	12	13	0
4 months	170	5	16	1
5 months	108	7	5	0
6 months	73	0	3	0
7 to 12 months	109	3	5	0
1 year	159	3	11	0
2 years	85	6	6	1
3 years	48	1	3	0
4 years	66	2	3	0
5 years	62	4	2	0
6 years	30	0	1	0
7 years	40	0	3	0
8 years	28	0	1	0
9 years	30	0	1	0
10 years	26	0	0	0
11 to 15 years	88	1	5	0
16 to 20 years	107	0	6	0
21 to 25 years	61	0	2	0
26 to 30 years	63	1	3	0
Over 31 years	6	0	1	0
	1757	90	108	2

	All cases	Last cases*
Percentage of deaths of all ages	5.12	1.85
Percentage of deaths under 1 year	8.39	1.66
Percentage of deaths from 1 to 2 years	1.88	0.00
Percentage of deaths from 2 to 5 years	0.50	8.33
Percentage of deaths from 5 to 10 years	2.10	0.00

The above table has been compiled from all the harelip cases which I have recently had access to. The deaths noted have occurred while the patients were under my care. In all cases I have watched the patient until the lip has thoroughly healed. No effort has been made to trace patients after they left my hands.

CONGENITAL FISSURES OF THE LOWER LIP

Sinus or Fistula in Lower Lip—In Professor Arthur Keith's Monograph on Congenital Malformations of the Palate, Face and Neck appears the following: "A bilateral cleft in the upper lip is frequently associated with a curious malformation of the lower lip, in which two fistulæ or recesses open

* These include cases operated during the past year. They have also been figured in the first two columns.

on the lower labial surface opposite the clefts in the upper lip. The orifice of each recess may be raised into a nipple-like process, which, when the mouth is shut, fits into the corresponding upper cleft. This was the condition in a specimen submitted to me by Mr. Woolcombe, which was excised from the lip of a boy, aged three months. The orifice of the recess was situated at the apex of the papilla; its fundus, about the size of a rice-grain, lay within the substance of the lip and was surrounded by mucous glands which opened into it. A layer of striated muscle surrounded the pocket, which, in nature, was clearly a localized invagination of the mucous membrane and glands of the lip. In three cases reported recently by Mr. R. C. Dunn, there was one in which the recesses opened on nipple-like processes; another in which the orifices were wide and flush with the surface of the lip; while in the third the two recesses were confluent, thus forming a transverse depression on the surface of the lower lip. The condition has been described by Mr. Bland-Sutton, Mr. Arbuthnot Lane, Mr. Clutton and Dr. Ballantyne. There is no example of this malformation in London museums. An appeal to comparative anatomy does not afford a satisfactory explanation. Seeing that the malformation is so closely associated with bilateral harelip and cleft palate, a condition which occurs normally in certain fishes, it is clearly in this vertebrate class that an explanation of the condition is to be sought. On each side of the middle line of the lower lip of sharks, exactly in the position where these recesses are found, open a group of mucous canals which are connected with nerve endings found in fishes. It is possible that these labial recesses have some relationship with these two mucous labial organs found in selachians, but the matter requires further investigation."

Author's Cases.—Four cases have come under my observation, presenting malformations of a nipple-like process developing on the lower lip, which corresponded in position to the clefts in the upper lip. In the first, that of a child three months old having unilateral harelip on the left side, a nipple-like prominence was present and when the lips were in proximity, it passed into the fissure of the upper lip. This prominence was made up of exceedingly hard, horny-like epithelium. It was excised at the time of the lip operation. The father had this defect, but no defect of the palate or upper lip (Fig. 354). The second case was that of a child five months old, with double harelip. There were two recesses in the lower lip, corresponding in position to the double harelip fissures. These recesses or pits were not unlike those we see in the lips of people whose upper teeth lap considerably over the lower teeth and make impressions of some depth in the surface of the lower lip. In this case I found that the father, whose upper lip was normal, had similar pits in the lower lip. He informed me that his father had the same kind of pits in the lower lip, though the upper lip was normal. The third case, that of a child four months old, with double harelip, showed two nipple-like processes extending upward from the lower lip corresponding to the positions of the fissures in the upper lip. These processes were hard, wart-like in

structure, two lines in length and conical in form. The mother of this patient had one horn-like projection on the lower lip, though the upper lip and palate were normal. The fourth was a woman twenty-three years old (Fig. 352). The large ducts extended about 2 cm. into the central part of the lower lip. Wooden toothpicks stained with iodin were placed in the ducts to indicate their locations clearly. I cannot account for these malformations except on the ground of heredity.

FIG. 354.—Two fistulæ in the lower lip extending to a depth of three-fourths of an inch. Large mucous glands were found at the base.

MEDIAN CLEFT IN LOWER LIP

In Professor Keith's work, speaking of median cleft in the lower lip and mandible, he states: "Among the 250 specimens of malformation examined, only four showed this condition: a full-time child in the museum at St. George's Hospital and three specimens in the museum of this college, one from an ass, another from a cockatoo and a third from a sparrow." Only one child in this great collection has this defect (Fig. 355). Professor Keith further says: "Seeing that the lower lip and mandible arise by the fusion of the right and left halves, their immunity from median fissure, as compared with the upper lip and palate, is surprising. In four other specimens there was an apparent cleft of the lower jaw, but, when the condition was more minutely examined, it was seen that the lesion was really the result of a bifurcation or doubling of the buccal cavity, an attempt at the formation of twins."

In answer to Professor Keith's query, it may be stated that when we study the relation of the upper jaw to the lower (Fig. 391) it is easy

to understand why the fusion of the right and left halves of the mandible takes place and why the bones and lip unite. In being brought upward by the traction of the muscles of mastication, the two halves of the mandible strike on the inclined planes of the maxillæ, and, while crowding them apart, crowd the halves of the mandible together, thus securing union of the parts. This is further evidence of the result of pressure of the mandible against the palatal plates of the maxillæ.

FIG. 355.—Median cleft of the lower lip. (*After Wölfler.*)

TABLE OF DEFORMITIES OF MUSEUM SPECIMENS

By

PROF. KEITH

	A	B	C	Total
Recesses and papillæ on the lower lip	...	...	...	....
Median clefts on the lower lip and mandible	...	1	3	4
Naso-maxillary cleft	...	4	...	4
Lateral nasal cleft	3	1	...	4
Mesial nasal clefts	...	...	5	5
Lateral nasal proboscis	...	...	...	....
Recess on nasal septum	...	...	...	....
Congenital perforation of nasal septum	1	...	...	1
Occlusion of anterior nares	2	...	...	2
Occlusion of posterior nares	...	...	...	....

(A) Human specimens in the Museum of the Royal College of Surgeons in England (Fig. 356).

(B) Human specimens in the museums of the metropolitan medical schools.

(C) Specimens of vertebrate animals, other than man, chiefly in the Museum of the Royal College of Surgeons.

The flexibility of the tissues of the face, especially of the lips, and the possibilities of molding them into any form the surgeon may desire to produce, are illustrated in the two portraits which I present here. They are taken

from the work of the scientist and African explorer, Dr. H. Karl W. Kumm. At the left is a Sara-Kabba lady with the beak face, the spoon bill type; at

FIG. 356.—Illustrates congenital fissures extending from the angle of the mouth backward to the occiput. (*Royal College of Surgeons.*)

FIG. 357.—Women of Sara-Kabba, Africa who have worn wooden discs to produce the lips shown. This is the height of fashion with these people. (*Dr. Kumm.*)

the right, another lady of the same tribe is shown with a plate lip (Fig. 357). This lower lip is the extreme of elegance in the Dark Continent.

The form of the lip in these two women results from the introduction of plates or bows of wood into the mouth in such a way as to exert continuous pressure upon the parts until they have the appearance here illustrated. There are two distinct ideas of beauty among these people. One is to shape the lips so that they resemble the beaks of birds; the other is known as the plate mouth. The lips of the women resemble large sized saucers. The disks worn to bring about this effect are three inches in diameter for the upper lip and six inches for the lower.

CHAPTER XXVII

CLEFT PALATE

Definitions.—Congential fissures of the palate, accompanied by harelip, are so conspicuous, of such frequent occurrence and their influence upon the patient so depressing, that measures looking toward their successful treatment have always been regarded by surgeons with deep interest. Harelip, with cleft palate, no doubt is one of the most distressing deformities which befalls mankind. The unfortunate sufferer, conscious of his deformity and his inability to speak distinctly enough to be understood by his associates, too frequently isolates himself and shuns the society of his fellow men. Palatal defects may be congenital or acquired. Cleft palate, including the velum, uvula, hard palate and alveolar process, with harelip either single or double, invariably is congenital. Defects of the palate resulting from trauma or disease do not occur as frequently as congenital defects.

The definition generally given for cleft palate is: "A congenital deformity, characterized by a fissure or fissures of the palate due to arrested development." From the foregoing, we find the opinions expressed are that congenital cleft palate is the result of incomplete development of the tissues necessary to enter into its normal formation. The opinions of authors thus expressed have been based, no doubt, on their observation of the open space between the oral and nasal cavities. The error might easily be accounted for since the open space suggests an absence of tissue. The deformity, the statements of many authors to the contrary notwithstanding, is *not* the result of *defective formation in the palatine plates*, nor *congenital deficiencies* of the parts in question, nor *arrested growth of the palate*, nor *absence of a portion of the palatine tissue. All children, who have congenital cleft palate, with rare exceptions, have in the palate at birth* the normal amount of tissue, although it is *not united* in the middle line. *It is cleft.* Later in life it may atrophy for want of use.

Embryology.—In the human embryo of about the third week, the face is in the process of development. From the front of the cephalic mass, five tubercles bud out, of which the first, the premaxillary, passes vertically downward (Figs. 358 and 359). This tubercle is double and forms the premaxilliary bones in which the incisor teeth are developed. It therefore bears the name 'incisor tubercle.' The rudimentary maxillary bones, which are widely separated, are developed at each side of the incisor tubercle though not united with it; while the fourth and fifth tubercles, which are separated in front, subsequently unite in the median line and form the mandible. Simultaneously the palate begins to be formed by the approach toward

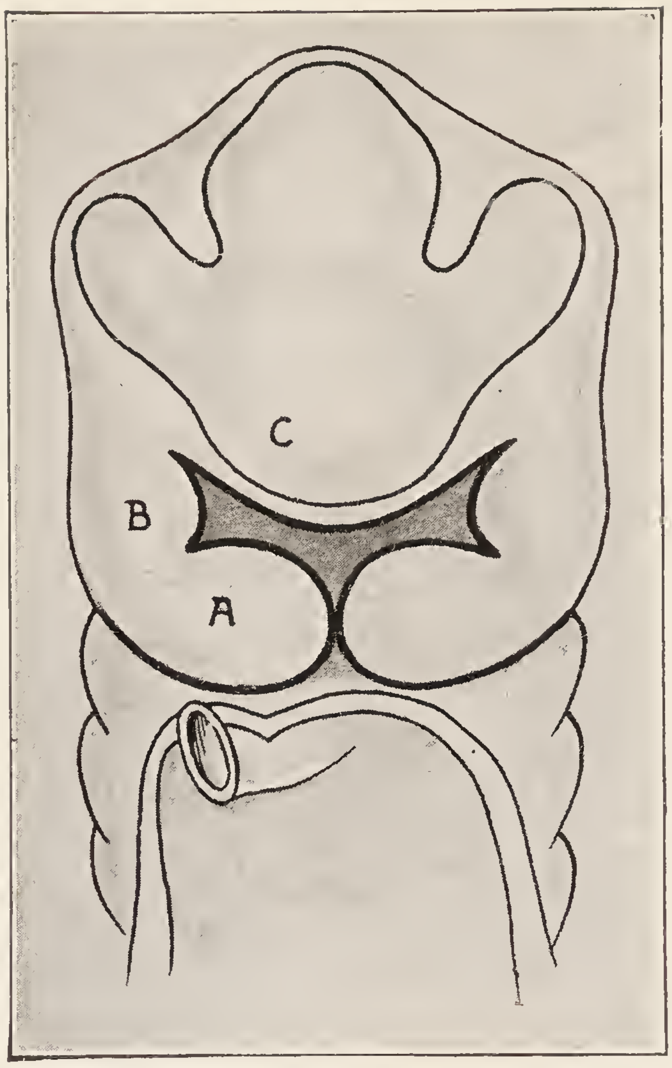


FIG. 358.—Head of fetus at end of fifth week. *C*, Frontal nasal process; *B*, maxillary process; *A*, mandibular processes. (*His.*)

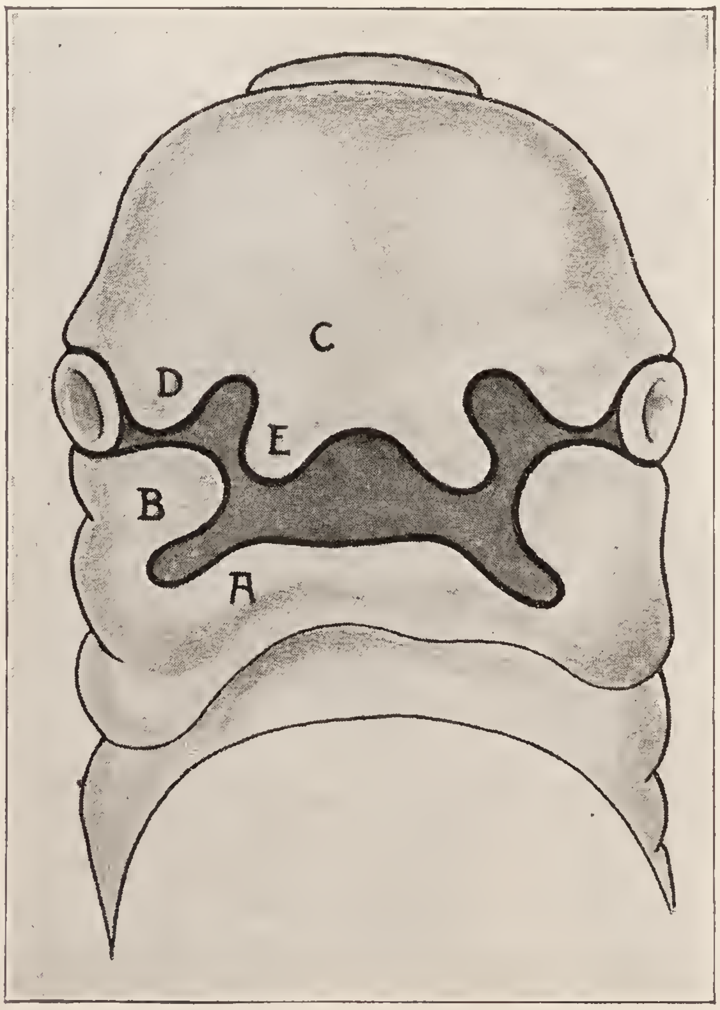


FIG. 359.—Head of fetus in the seventh week. *A*, The now united mandibular processes; *B*, the maxillary process; *C*, fronto-nasal process; *D*, lateral nasal process; *E*, globular processes attached to the nasal part of the fronto-nasal process. The central nasal processes are separated from the lateral on each side by the lateral nasal groove which represent the anterior nares. (*After His.*)

the median line of the two horizontal plates developing from the maxillary processes on either side. If the palatal processes of the maxillæ unite in the median line and blend also with the premaxillary bones and the vomer grows downward to meet the palatal processes in the line of union, the upper jaw

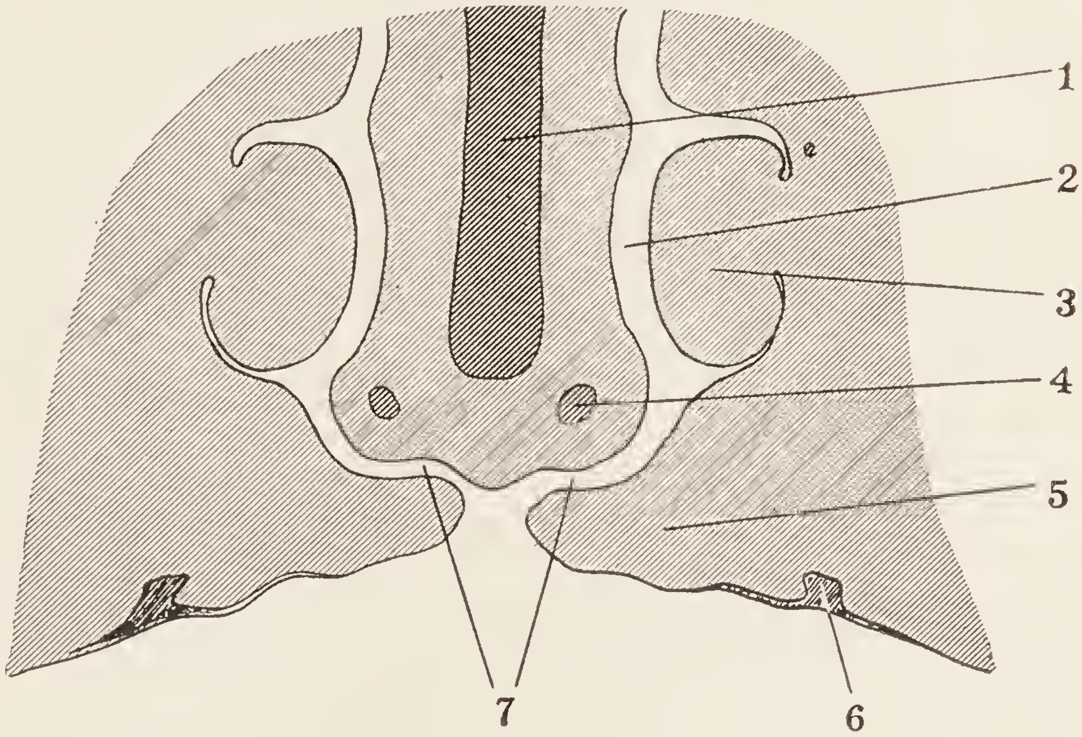


FIG. 360.—Eight centimeter embryo. 1. Nasal septum; 2, nasal cavity; 3, turbinal; 4, cartilage paraseptalis (*Jacobson*); 5, palatine process; 6, tooth rudiment; 7, connection of the nasal cavity with oral cavity. (*Warnekros.*)

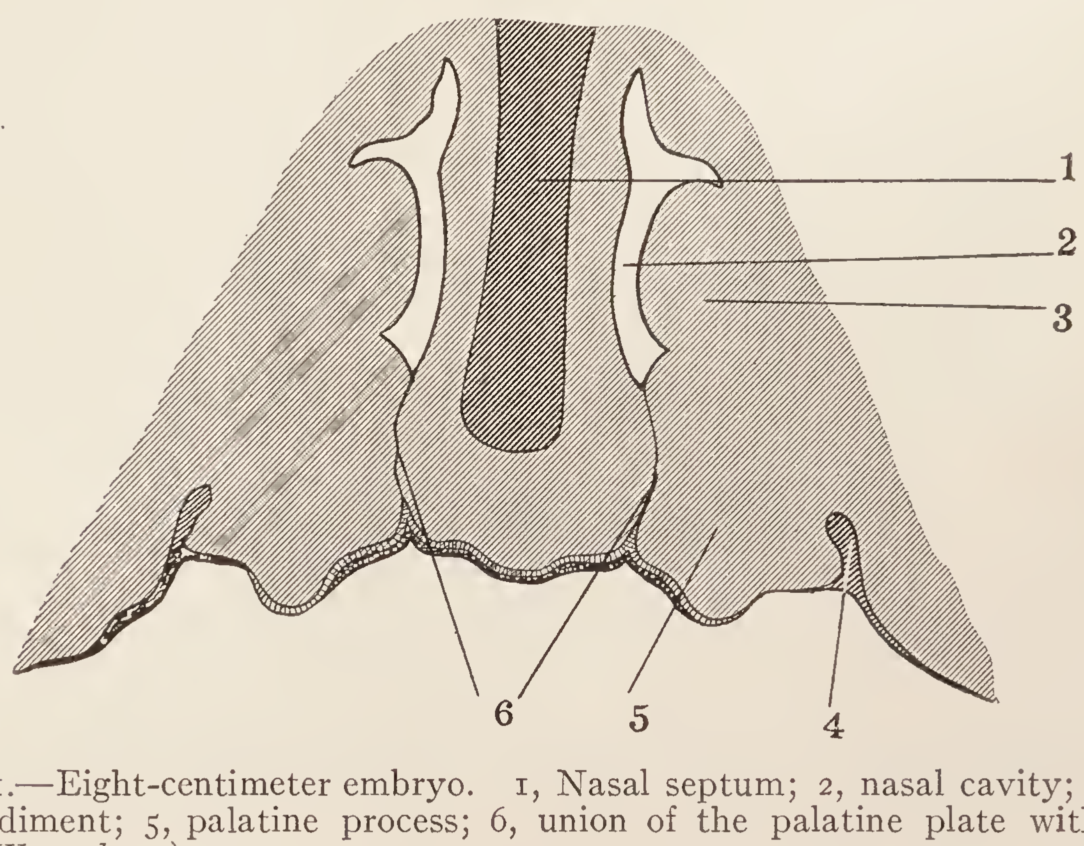


FIG. 361.—Eight-centimeter embryo. 1, Nasal septum; 2, nasal cavity; 3, turbinal; 4, tooth rudiment; 5, palatine process; 6, union of the palatine plate with the nasal septum. (*Warnekros.*)

and lip will be normal. By the beginning of the third month, the parts which enter into the formation of the palate should be united (Figs. 360 and 361). The embryological development of the palate is beautifully and accurately illustrated by Prof. Inouye. Figs. 362 to 370 are from his work. If, however, the superior maxillary and premaxillary processes fail to unite

with each other, cleft palate and harelip, in one of their many forms, will result (Figs. 371 and 372).

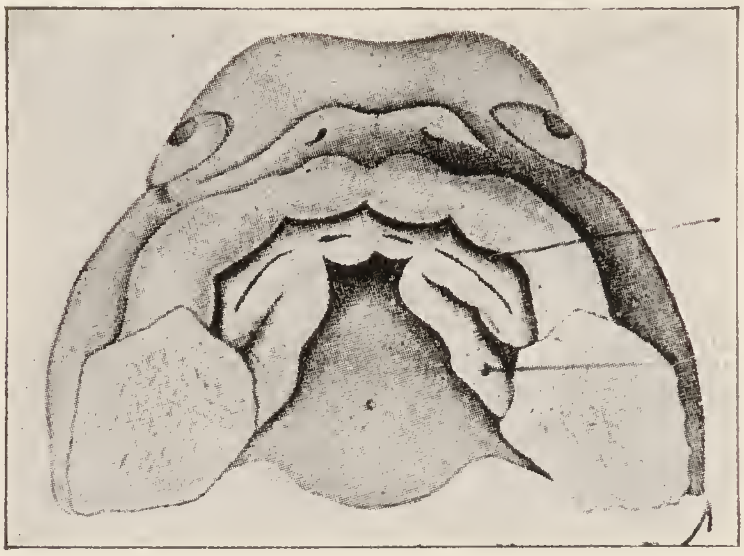


FIG. 362.—View of roof of oral fossa of embryo, showing lip groove and the formation of the palate. *Lg*, Lip groove; *Pp*, palatal process. (*His.*)

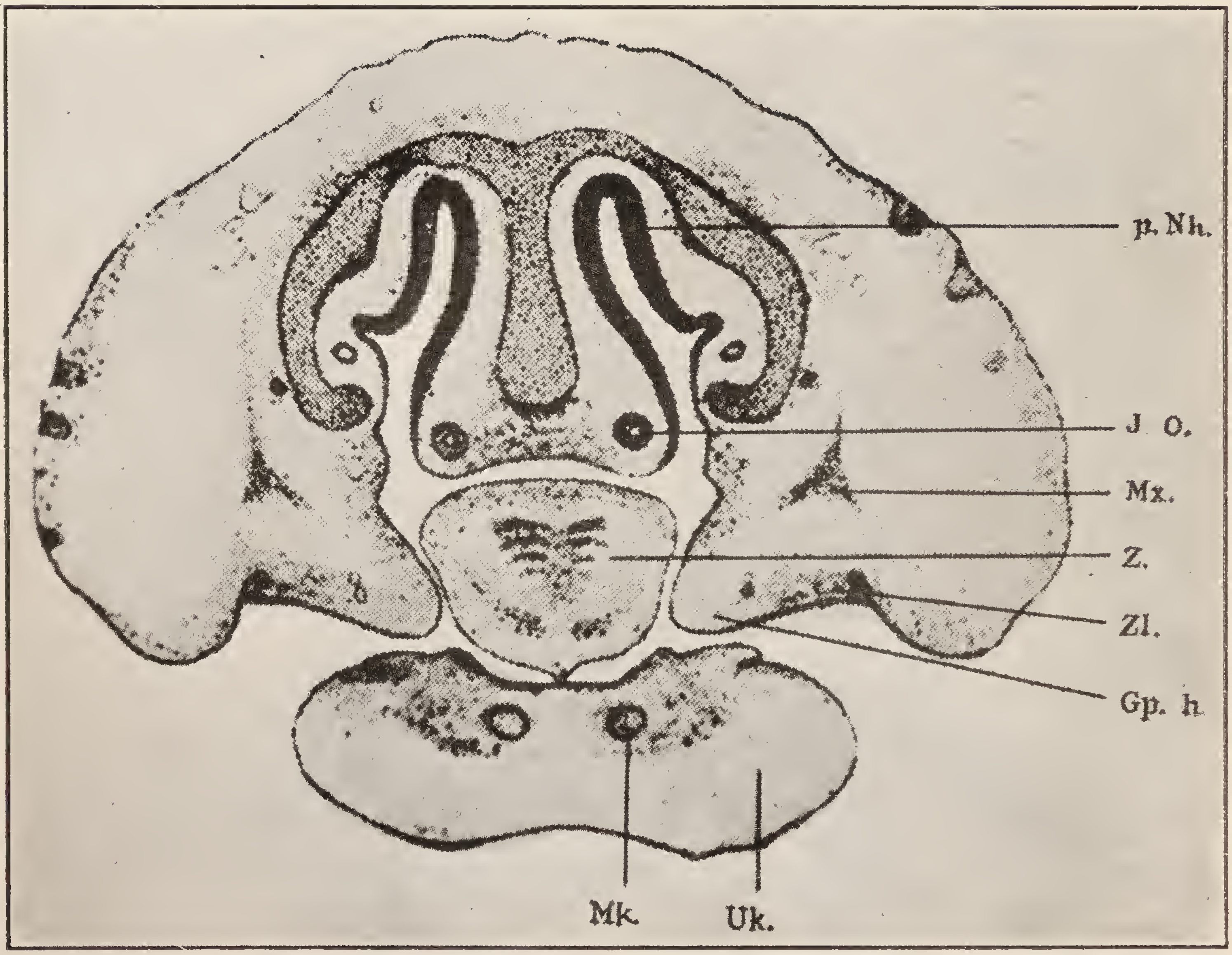


FIG. 363.—Frontal section through face of embryo of mole, showing position of tongue during development of the palate. *Mx*, Maxillary; *Z*, tongue, *Zl*, dental lamina; *Gp*, palatal process; *Mk*, Meckel's cartilage. *Uk*, mandible. (*Inouye.*)

To better understand the mechanism by which cleft palate is formed, the embryology of the enamel organ should be looked into. I can do no better than to quote rather extensively from Bödecker.[1] He states on page 149,

[1] Anatomy and Pathology of the Teeth, 1894.

"Let us consider the direction taken by the epithelial cord of the *enamel-organ* into the depth of the connective tissue up to the time when the enamel-organ is ready for the formation of the enamel. The first trace of the future tooth in the human embryo is visible about the sixth week of intra-uterine

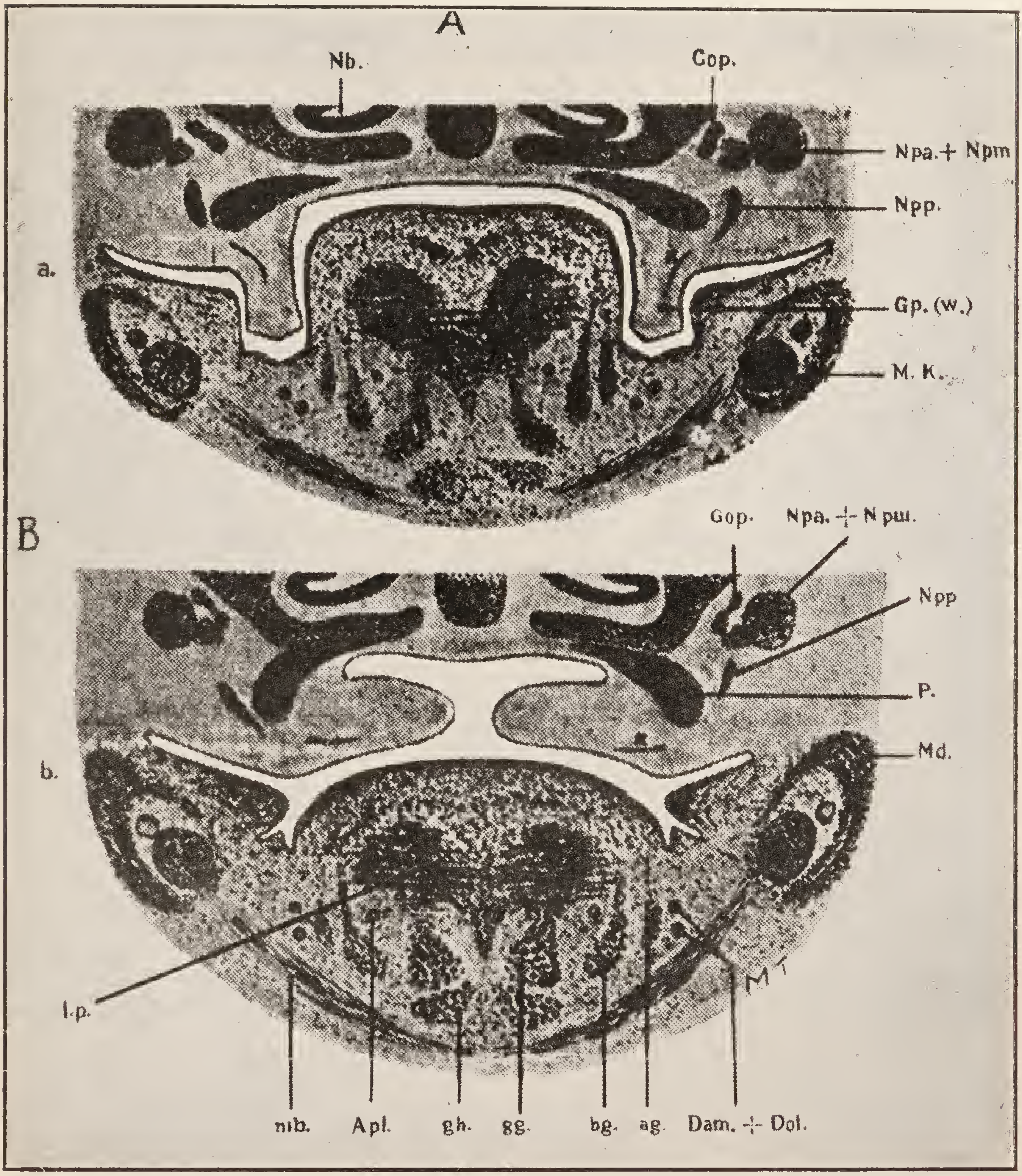


FIG. 364.—Frontal section through face of embryo, later stage than Fig. 363, showing change in position of palate processes and change in position and form of the tongue. (*Inouye.*)

life, when the epithelium of the oral cavity is as yet little developed. Here we notice a furrow which is situated close behind the lip, and is succeeded by an elevation of medullary tissue (Fig. 373).

After this period follows the formation of an epithelial peg, appearing

not at the bottom of the primitive dental furrow, but at some distance from the latter. This peg appears as a reduplication of the epithelial layer covering the elevation behind the furrow (Fig. 374).

Shortly afterward, the epithelial hill has gained in height considerably, and from the point which connects the hill with the rest of the oral epithelium, the original peg has elongated into an epithelial cord. A striking feature of this cord is that from its periphery arise blunt or slightly-pointed offshoots, while at the same time its distal end is noticeably broadened, the epithelia

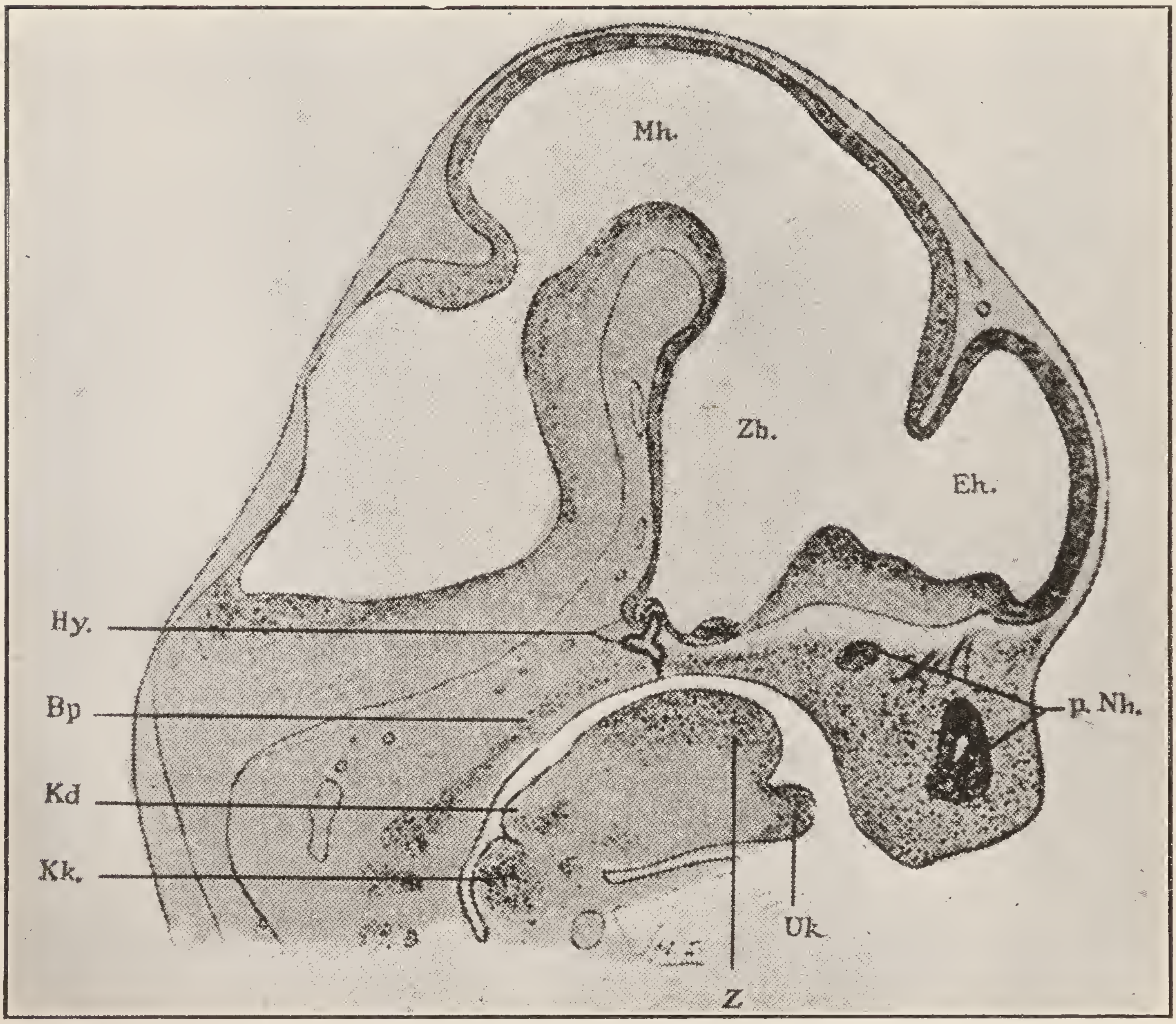


Fig. 365.—Sagittal section of embryo of mole, showing relation between the tongue and the skull. *Z*, tongue; *Uk*, mandible; *Hy*, hypophysis; *Bp*, basal plate; *Kd*, epiglottis; *Kk*, Larynx. (*Inouye.*)

being arranged in radiating tracts throughout, but most markedly in the club-shaped enlargement of the distal end (Fig. 375).

In the third month of embryonal life, the *epithelial hill* still remains a prominent formation. From the point of its junction with the other epithelium arises the epithelial cord, which varies, to some extent, both in width and in its course. Sometimes the cord runs nearly parallel with the base of the oral cavity, becoming devious on the way to its club-shaped distal end. Its periphery is slightly fluted, and from its lower contour arise scanty but

strongly-marked epithelial offshoots, the significance of which is not perfectly plain. We may assume that a large secondary offshoot forms the epithelial cord of a future permanent tooth, but as to the significance of the short *secondary offshoot* we can only suggest that the epithelium primarily producing the cord at first assumed a direction which afterward was changed. This much is certain, that such short secondary offshoots perish and disappear in the course of further development. It would certainly be a bold hypothesis

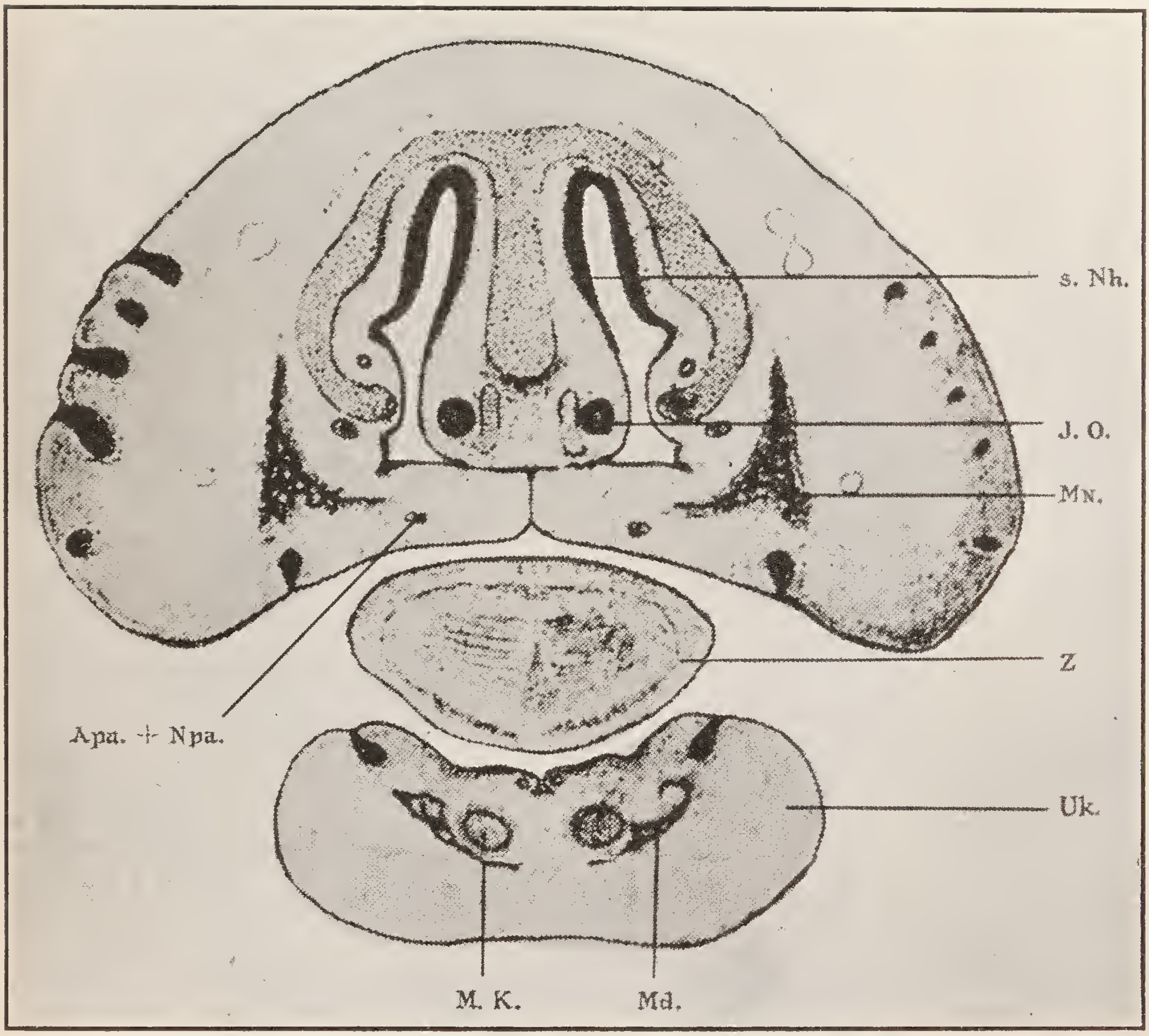


Fig. 366.—Frontal section through face of embryo, later stage than Fig. 365, showing union in median line of palatal processes. (*Inouye.*)

to consider all such short secondary offshoots as germs of supernumerary teeth, or of third dentitions. They are too common as compared with rare cases in which supernumerary teeth are found. At this stage of development the first trace of the papilla (the future dentin) is noticeable (Fig. 376).

Sometimes the epithelial cord is broad, exhibiting comparatively few blunt secondary offshoots. Its course is more or less vertical, into the depth of the connective tissue of the jaw. The epithelium within the cord is arranged into groups separated by trabeculæ somewhat resembling those of true myxomatous connective tissue. The club-shaped end of such a cord at

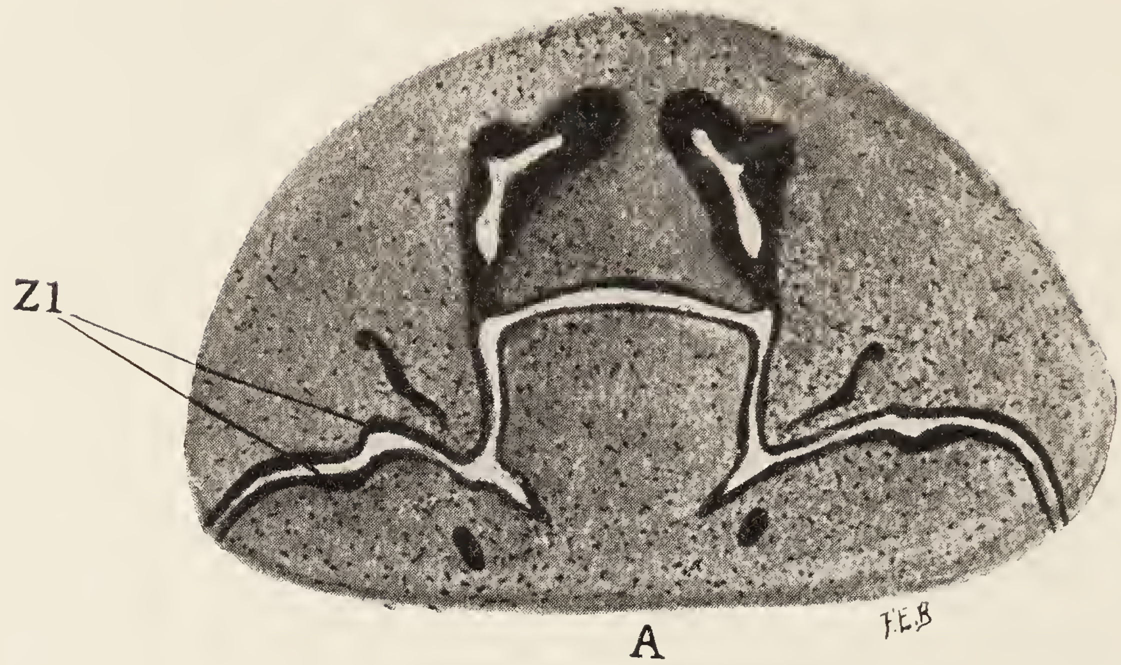


Fig. 367.

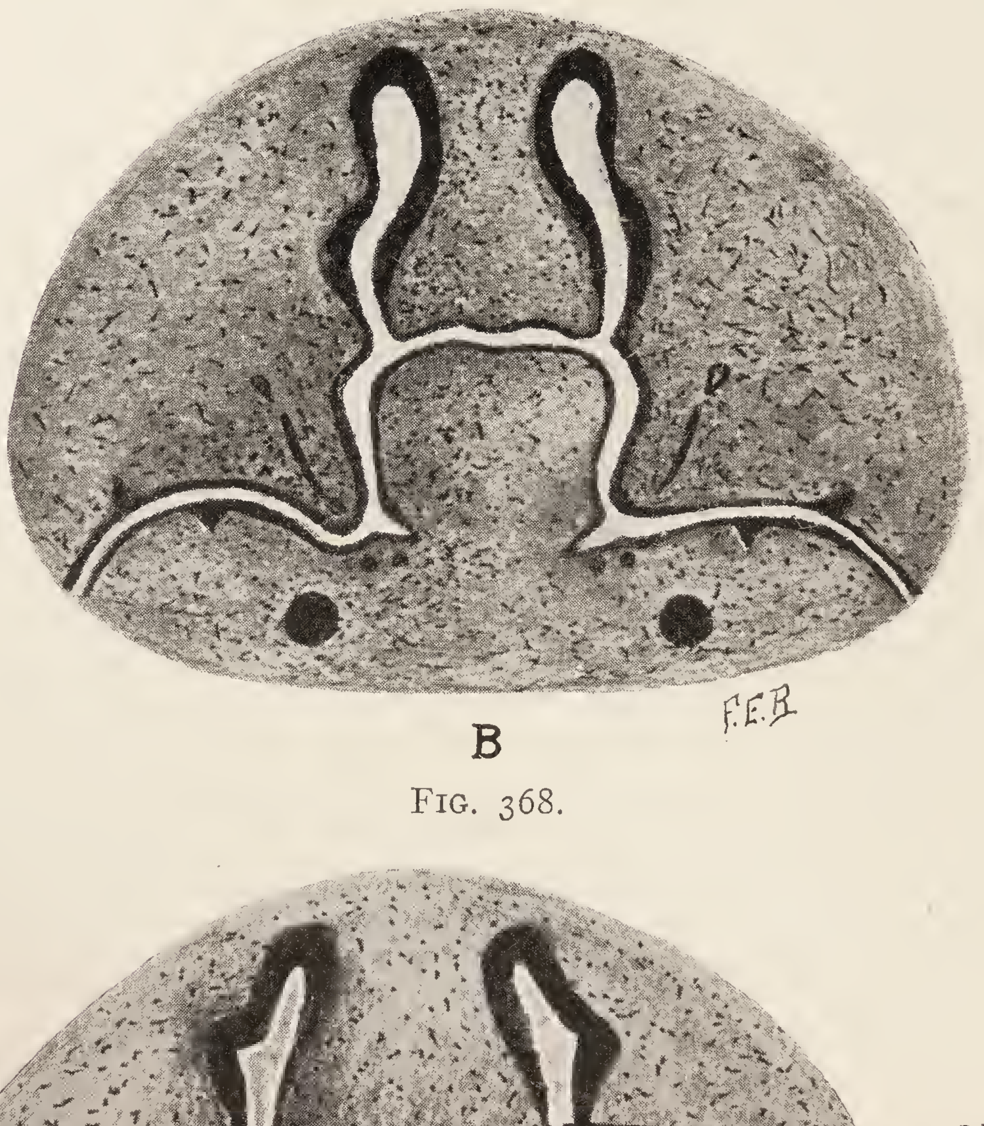


Fig. 368.

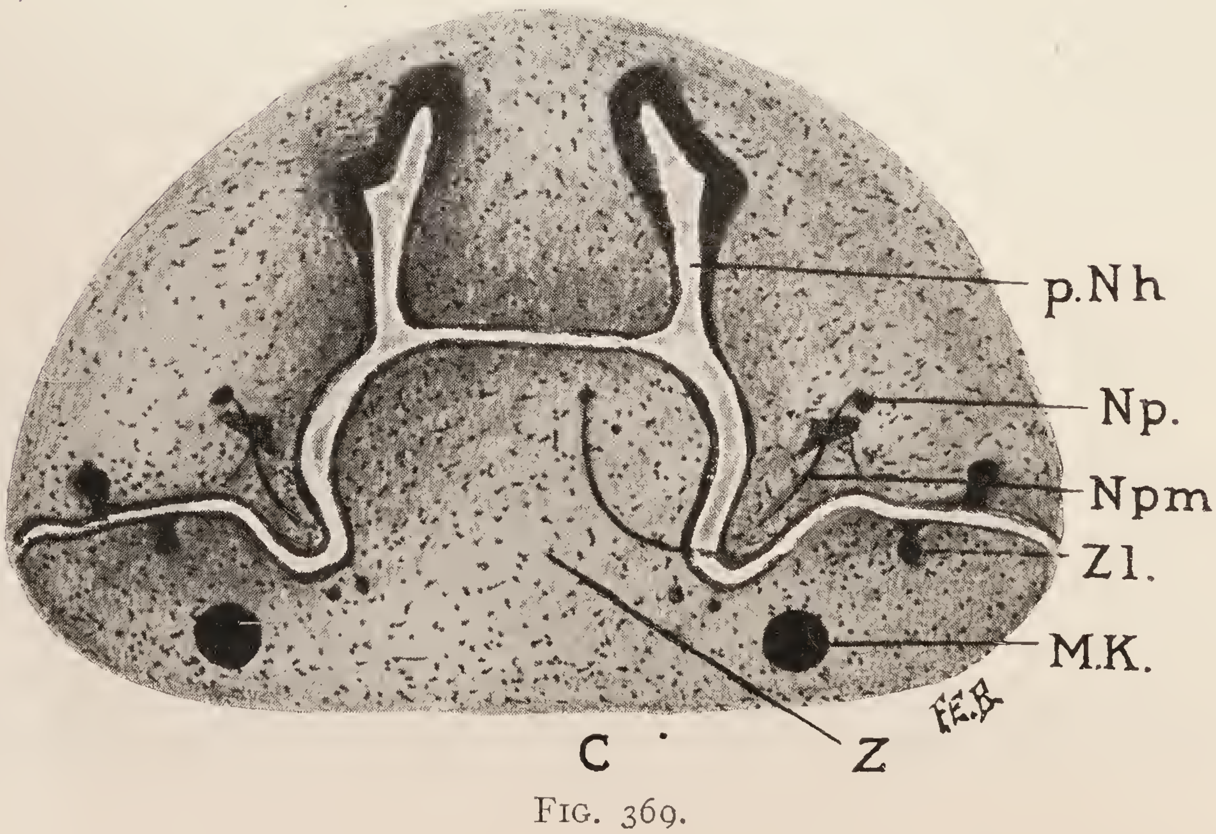


Fig. 369.

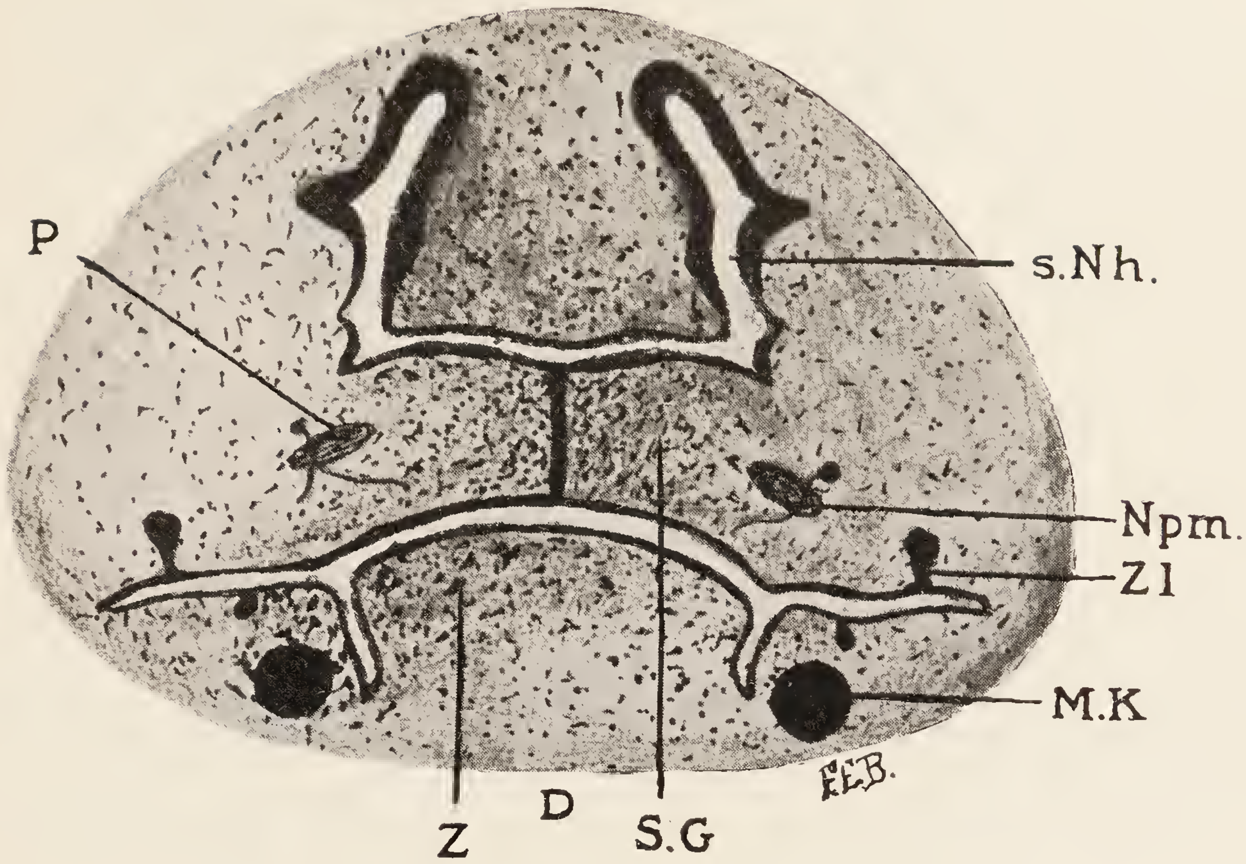


Fig. 370.

Figs. 367 to 370.—Frontal sections through oral and nasal cavities, showing relative development of the palate and dental lamina. *Zl*, Dental lamina; *Z*, tongue; *SG*, palatal process; *MK.*, Meckel's Cartilage; *pNh.*, primitive nasal cavity; *s.Nh*, secondary nasal cavity. (*Inouye.*)

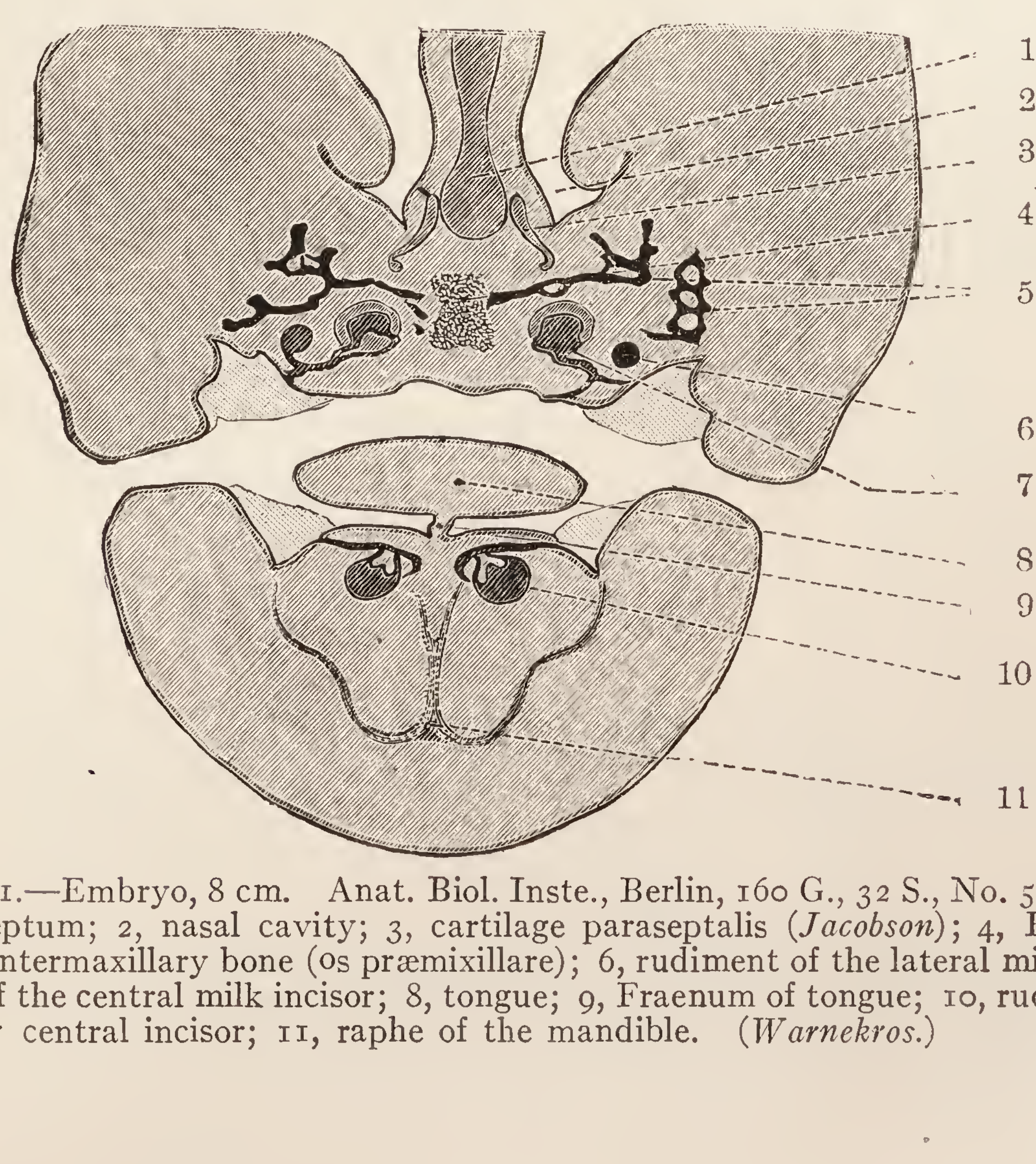


Fig. 371.—Embryo, 8 cm. Anat. Biol. Inste., Berlin, 160 G., 32 S., No. 5, last section. 1, Nasal septum; 2, nasal cavity; 3, cartilage paraseptalis (*Jacobson*); 4, Raphe of the palate; 5, intermaxillary bone (os præmixillare); 6, rudiment of the lateral milk incisor; 7, rudiment of the central milk incisor; 8, tongue; 9, Fraenum of tongue; 10, rudiment of the mandibular central incisor; 11, raphe of the mandible. (*Warnekros.*)

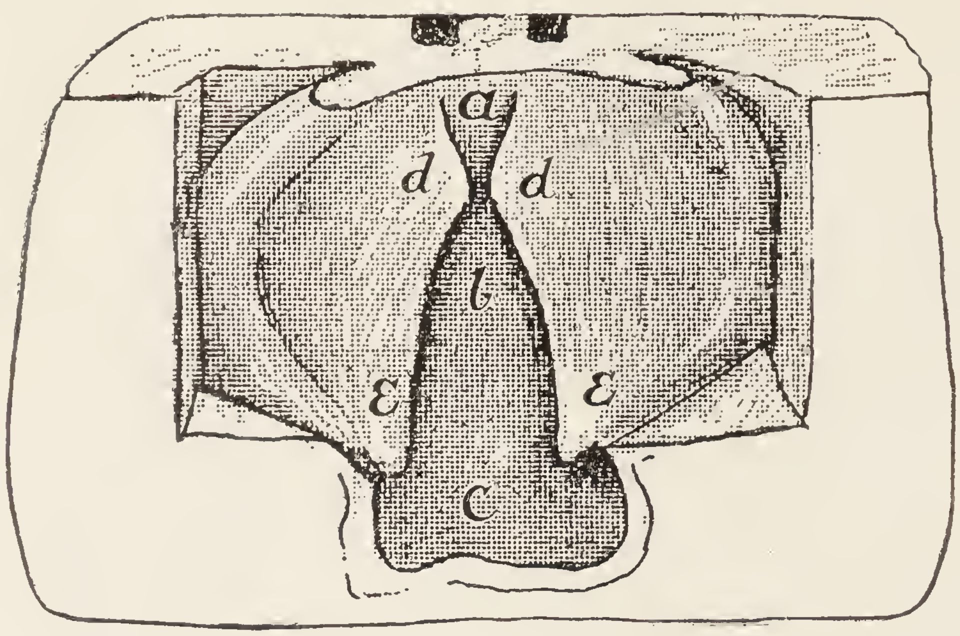


Fig. 372.—Model of the developing palate of a human fetus about six weeks old (28 mm. long) (*Anna Pölzl*). *a*, Premaxillary part of palate; *b*, septum of nose; *c*, naso-pharynx; *dd*, maxillary plates about to meet; *ee*, soft palate and uvula. (*Keith.*)

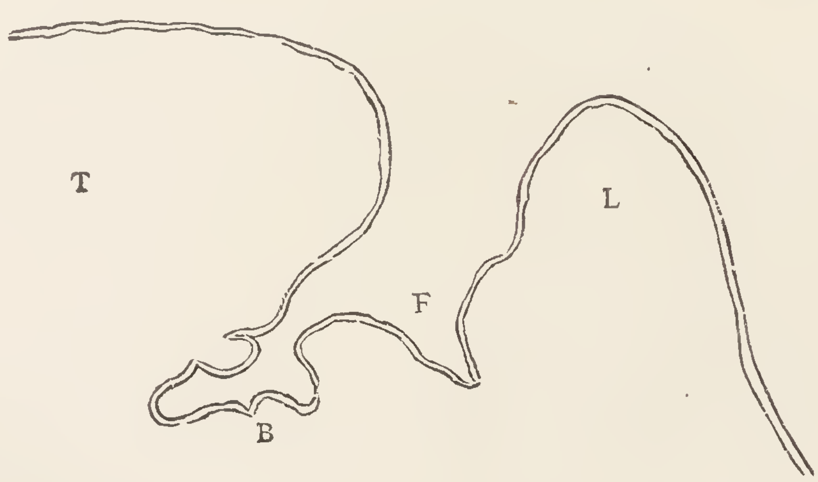


Fig. 373.—Human embryo six weeks old. Frontal section. *T*, Tongue; *L*, lip; *B*, base of oral cavity; *F*, furrow, in transverse section, funnel-shaped. Magnified 25 diameters. (*Bödecker.*)

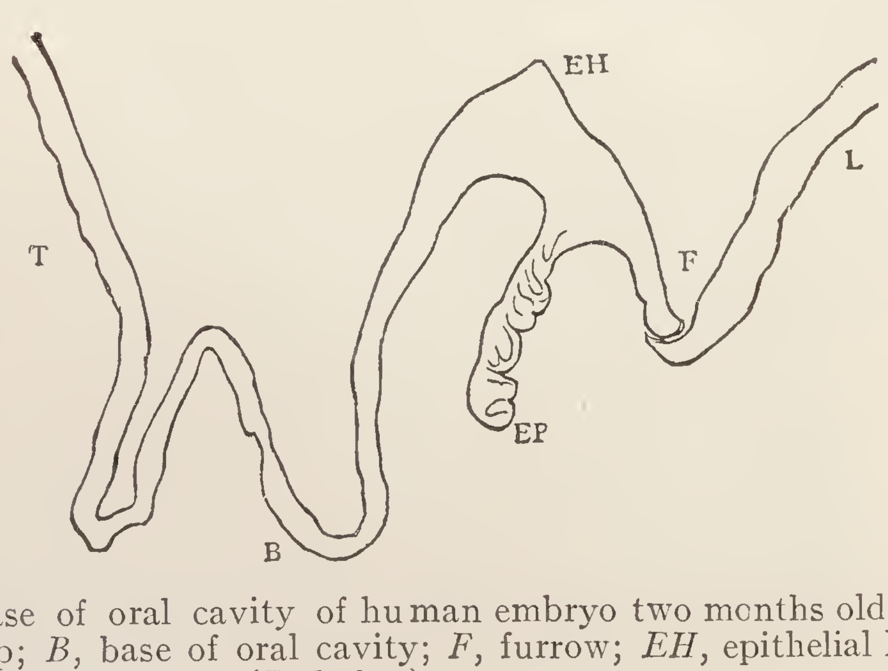


Fig. 374.—Base of oral cavity of human embryo two months old. Frontal section. *T*, Tongue; *L*, lip; *B*, base of oral cavity; *F*, furrow; *EH*, epithelial hill; *EP*, epithelial peg. Magnified 25 diameters. (*Bödecker.*)

this period shows a slight separation of the columnar epithelium into an outer and an inner layer, whereas the center of the club-shaped enlargement is occupied by medullary corpuscles, which as yet do not exhibit the characters of a myxomatous reticulum. Unquestionably this medullary tissue has arisen

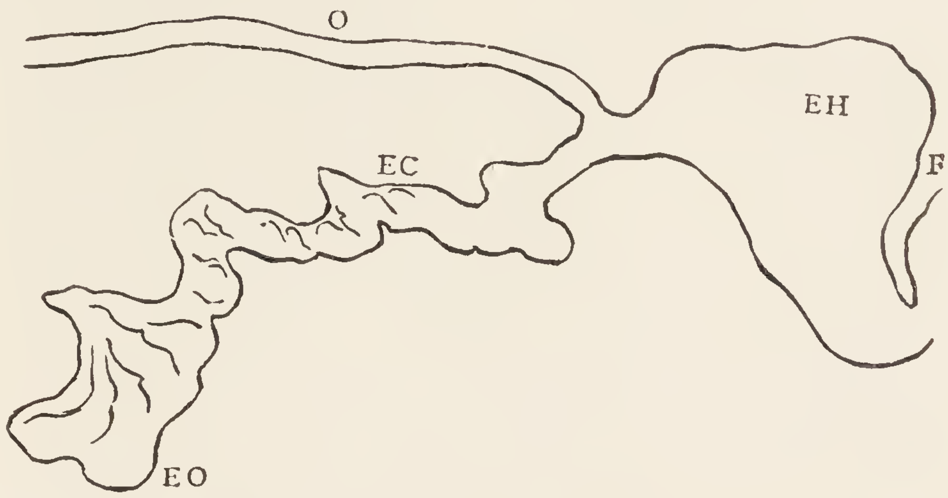


Fig. 375.—Base of oral cavity of human embryo two and one-half months old, frontal section. *EH*, Epithelial hill; *O*, epithelial lining of base of oral cavity; *F*, furrow; *EC*, epithelial cord of enamel-organ; *EO*, club-shaped enlargement of the epithelial cord, the future enamel-organ. Magnified 25 diameters. (*Bödecker.*)

from epithelia, which originally filled the club-shaped end of the cord, and it is this medullary tissue from which soon afterward, the myxomatous reticulum of the enamel organ proper originates (Fig. 377).

When the embryo is at the age of four and a half months, the development of the enamel-organ has still further proceeded; its myxomatous tissue is

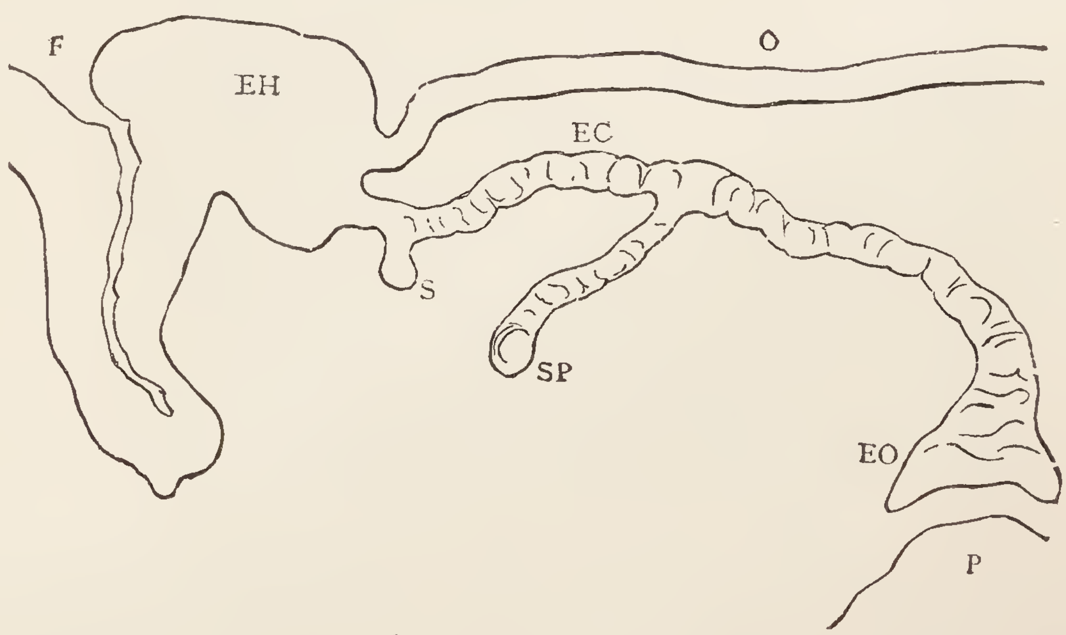


Fig. 376.—Base of oral cavity of a human embryo three months old. *EH*, Epithelial hill; *F*, furrow, sharply marked and lined by a heavy layer of flat epithelium; *O*, base of oral cavity; *EC*, epithelial cord; *EO*, club-shaped end of the epithelial cord, the future enamel-organ; *S*, secondary offshoot; *SP*, secondary offshoot, possibly a germ of the permanent tooth; *P*, papilla. Magnified 25 diameters. (*Bödecker.*)

plainly marked, and the papilla has correspondingly gained in bulk. The specimen illustrated is noteworthy for its short vertical epithelial cord, which is directly in connection with the lining epithelium of the oral cavity. The secondary offshoots are but short, and not a trace of a peg for the permanent

tooth is visible in this section. The cup of the enamel-organ is lobulated, evidently belonging to a future molar (Fig. 378).

Fig. 377.—Floor of oral cavity of a human embryo three months old. *EH*, epithelial hill; *F*, furrow; *O*, oral epithelium; *EC*, epithelial cord; *S*, secondary offshoot; *EO*, medullary tissue of enamel-organ; *P*, papilla, detached. Magnified 25 diameters. (*Bödecker.*)

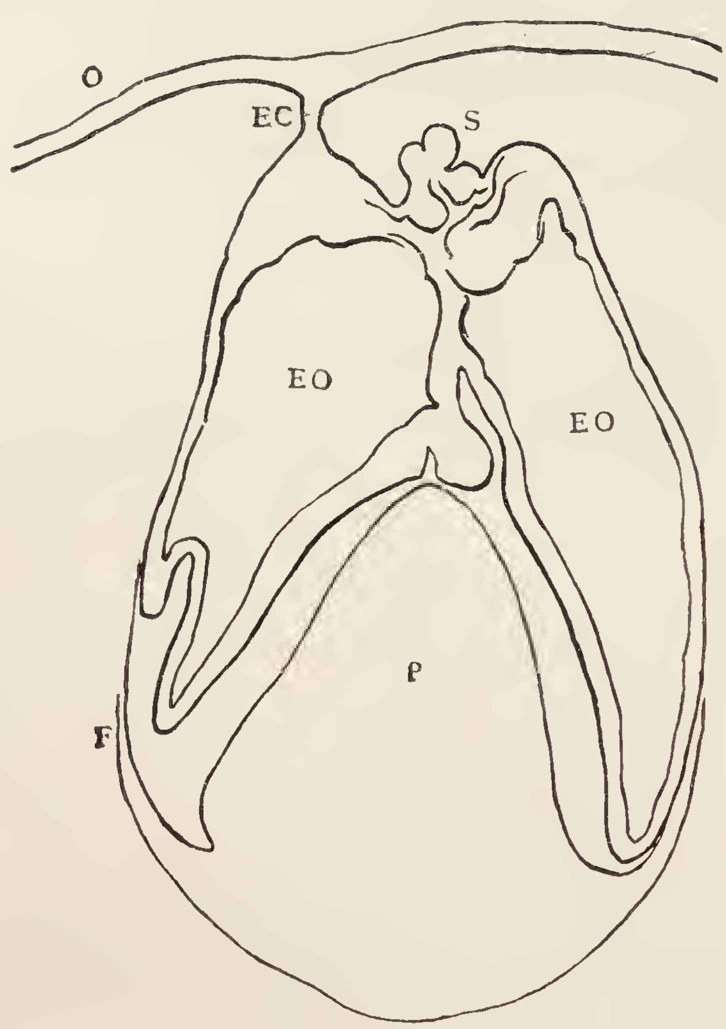


Fig. 378.—Enamel-organ and papilla of human embryo four and one-half months old. *O*, oral epithelium; *EC*, short epithelial cord; *S*, secondary offshoot; *EO*, enamel-organ; *P*, papilla; *F*, follicle. Magnified 25 diameters. (*Bödecker.*)

We now proceed to consider the changes in the enamel-organ about the beginning of the fifth month. If we examine the cup-shaped enlargement of

the enamel-organ at this period, we observe a distinctly marked border composed of columnar epithelia, whereas the interior of the cup is filled

FIG. 379.—Epithielal cord terminating in the enamel-organ. Human embryo at the end of the fourth or the beginning of the fifth month of intra-uterine life. *O*, stratified epithelium of the oral cavity; *TT*, epithelial cord of temporary tooth; *PT*, epithelial cord of permanent tooth; *N*, epithelial nests and buds at the bottom of the furrow and along the cords of both the temporary and permanent teeth; *M*, myxomatous tissue of the enamel-organ (stellate reticulum); *EE*, external (outer) epithelium; *IE*, internal (inner) epithelium; *I*, intermediate layer between inner epithelium and myxomatous tissue; *P*, papilla with numerous blood-vessels; *E*, embryonal or medullary tissue crowded with medullary corpuscles at a certain distance from the epithelial formation. Magnified 500 diameters. (*Bödecker.*)

with medullary corpuscles, which, in the center, present the so-called stellate reticulum. At the end of the fourth and the beginning of the fifth month, we invaribly find some epithelial cords, which, at their anterior

ends, are broadened and contain a distinctly marked stellate reticulum (Fig. 379).

Toward the end of the fourth month and the beginning of the fifth month, the stellate reticulum is composed of nucleated protoplasmic bodies, with a varying number of branching and interconnecting offshoots. With the low powers of the microscope the basis-substance in the meshes, inclosed by the

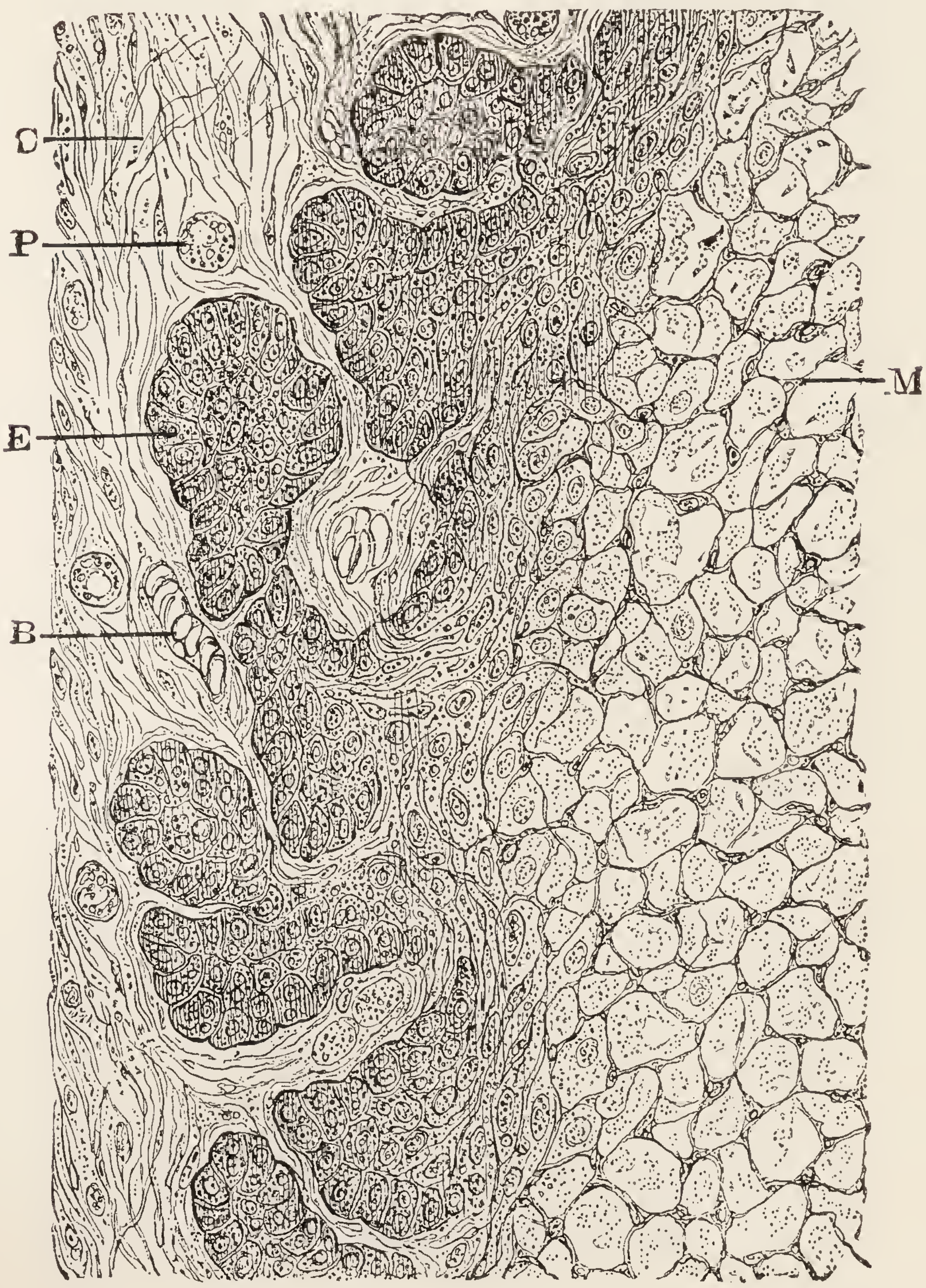


Fig. 380.—Budding of the external epithelium of the enamel-organ of a human fetus seven months old. *M*, myxomatous reticulum of the enamel-organ; *C*, delicate fibrous connective tissue; *E*, epithelial bud arisen from the external epithelium; *P*, large protoplasmic body filled with glistening coarse granules; *B*, newly formed blood-vessel. Magnified 500 diameters. (*Bödecker.*)

corpuscles and their offshoots, appears to be homogeneous and structureless. The highest powers, however, reveal in this basis-substance the presence of a delicate reticular structure, even without the addition of any reagent. This structure has arisen by a direct transformation of the original medullary corpuscles into basis-substance. In the highest development of the stellate reticulum, such as seen in the seventh and eighth months of fetal life, the

nucleated corpuscles are more slender, and the reticulum is composed mainly of delicate branching and intercommunicating fibers.

The further changes of the external epithelium are of considerable interest. While about the fourth month of intra-uterine life the inner positions of the

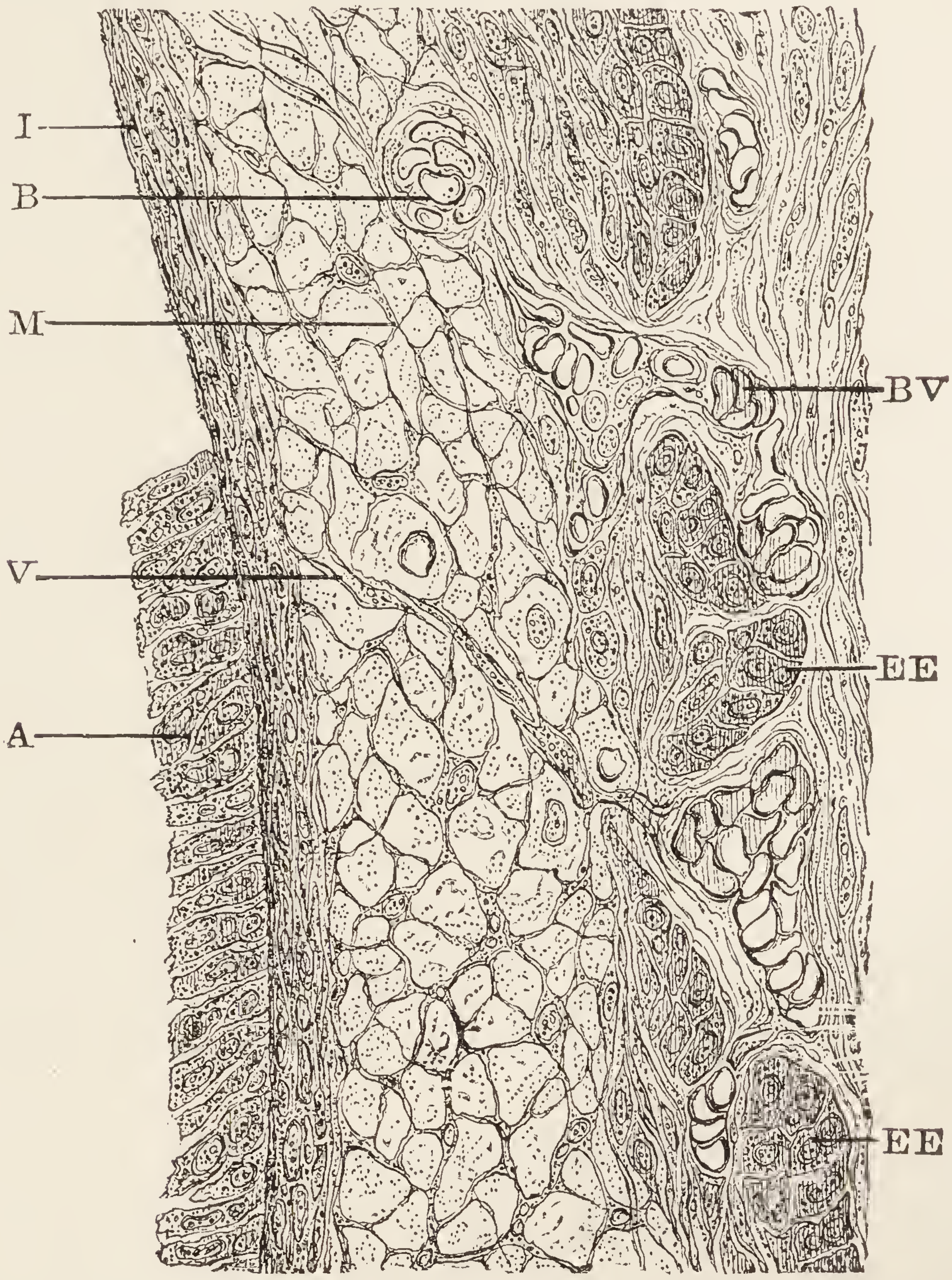


FIG. 381.—Isolated epithelial nests of the place of the enamel-organ corresponding to the neck of the future tooth of a human fetus seven months old. *M*, myxomatous reticulum of the enamel-organ; *A*, row of ameloblasts; *I*, intermediate layer composed of spindles and fibers; *B*, vesicle filled with hematoblasts and red blood-corpuscles; *V*, capillary blood-vessel forming from trabeculæ of the myxomatous reticulum; *BV*, irregular spaces filled with hematoblasts and red blood-corpuscles, lined by endothelia and in an incomplete connection with forming capillaries; *EE*, epithelial nests, the remnants of the external epithelium. Magnified 500 diameters. (*Bödecker.*)

external epithelium are, as mentioned above, transformed into medullary tissue and participate in the formation of the myxomatous enamel-organ, a single row of cuboidal epithelium is left. From the remains of this external epithelium, a new growth takes place of a markedly centrifugal character. By a multiplication of the epithelial elements, solid buds and knobs are formed, well known to previous observers (Fig. 380).

At the time when the buds sprout from the external epithelium, an active new formation of blood-vessels and blood-corpuscles takes place in the immediate vicinity of the buds. At first we notice large protoplasmic bodies with coarse granules, which were well known to Theodore Schwann, in 1839, by the name of blood-cells. With the increase of the size of these bodies, the granules likewise become coarser, and assume the properties of the so-called hematoblasts. These grow up to the size of red blood-corpuscles, and we not infrequently encounter in the bays between the buds, groups of hematoblasts or fully-developed blood-corpuscles, apparently isolated and in no connection with blood-vessels. At last, capillary blood-vessels arise from the conference of blood-cells which are filled with red corpuscles. The splitting of the external epithelium into isolated buds and nests of an epithelial character is especially marked near the neck of the future tooth (Fig. 381). At this place the amount of myxomatous enamel-organ in a seven-months' fetus is usually small, since a great quantity of it has already been transformed into enamel tissue. But even here a few small and isolated epithelial nests are seen, surrounded by a large number of capillary blood-vessels filled with blood-corpuscles. It is evident that all these blood-vessels are newly formed, and indeed we cannot trace the formation of blood-vessels in this situation step by step. Even the myxomatous trabeculæ of the enamel-organ participate in the formation of the capillary blood-vessels. We have seen closed spaces or vesicles, sprung from the basis-substance of the myxomatous tissue, filled with hematoblasts and red blood-corpuscles, partly in connection with already formed or forming capillaries. No doubt the living matter inclosed in the basis-substance has grown into hematoblasts. This process is indicated by the appearance either of coarsely granular or of compact glistening nuclei in the meshes of the myxomatous reticulum."

ETIOLOGY OF CLEFT PALATE

The literature on this subject is voluminous and largely conjectural. In reviewing it we find a great similarity in the opinions expressed. Heredity, prenatal impressions and imperfect nutrition during the early months of gestation are assigned as cause. Congenital cleft palate has a predisposing and an exciting cause.

Predisposing Causes.—The predisposing cause is heredity and the presence of supernumerary teeth, or, possibly, intervening mucosa which prevents the submucous tissue from uniting.[1] The factor of heredity is so well recognized that reference to it here might seem unnecessary. In many cases the physical characteristics of the parents, normal or abnormal, may be observed in their children. The shape of the head, nose, eyes and other features often strongly resemble those of one parent. As in the cases below described, the parents may have normal palates while a grandparent, or even

[1] Bödecker.

a great grandparent (and, no doubt, progenitors farther back of whose physical conditions the parents know nothing), having had the defect, transmit it to grandchildren or to generations even farther away. It is thus that the law of atavism, or reversion to type, asserts itself. The statement parents often make that no ancestor ever had a cleft palate or harelip applies usually only to their grandparents whom they have personally known. As to those farther back, as a rule, they know nothing.

Maternal Prenatal Impressions.—Maternal prenatal impressions are firmly believed in by many mothers, but proof that cleft palate has been due to such impressions has never been established. Regarding the cause of congenital cleft palate, Mr. Edmund Owen, in his Monograph on Cleft Palate and Harelip, states "It is improbable that maternal impressions have anything whatever to do with it. As a rule, the supposed fright comes long after the lips and features are developed. The lips are completely formed by the ninth week. Heredity has a powerful influence in many cases.[1]

The mother, who is inclined to ascribe the occurrence of a harelip to some shock or fright received during her pregnancy, is generally somewhat late with regard to her explanation. At the very beginning of the third month of gestation (ninth week), the fissures about the orbit, nose and mouth have been effaced and the embryo, who, by the by, has only just made up its mind as to which sex it will join, is already beginning to assume, though as it were in a rough sketch, a definite facial expression. At a later period than this no maternal impression, however severe, could possibly have the least effect. What is done cannot be undone." It would seem that in the case of cleft palate, harelip, or any other congenital deformity in a twin, if prenatal impressions were a factor, both children should be similarly defective. The author has performed six operations for cleft palate, with harelip, on twin children. In each case one child of the pair was normal. In the case of three, the defective child was larger, weighed more and was the more robust at birth. I have little faith in the theory that prenatal impressions cause failure of union of the bones. In the greater number of cases, in which this cause has been given, it has been found that the mental shock occurred subsequent to the fifth month when, if physiological processes were not interfered with, union of the bones would be complete. It is too apparent to require argument that a mental impression could not separate a suture. Prenatal impressions, possibly, may be a factor in causing failure of union, but we have no authentic evidence to that effect. Defective nutrition or general debility of the mother during the early months of gestation, from any cause, may delay union of the palatal plates. *Nature does not fail to develop the necessary bone and soft parts to form a normal palate, but it does fail to bring the parts into apposition and unite them.*

Regarding the etiology of cleft palate, it is interesting to note the observation made by Dr. O. A. Strauss, who was engaged in the study of the abnor-

[1] See Chapter on Eugenics.

malities of animals in the zoölogical gardens at Berlin, October, 1913. Four years ago 32 jaguars were born of one mother by the same sire within a period of one year. All of these animals had cleft palate and all died. At that time they were fed cold meat from which the blood had been allowed to escape. Three years ago, the diet was changed and the parent animals were fed with meat which was still warm and which contained blood. Since this inauguration there have been two litters a year (about 25 jaguars), not one of which has had a cleft. Petrus Olson, in charge of the animals, states that he is able to eliminate cleft palate and harelip in all the animals of this family. It would be interesting to work out a system of diet in the human race, especially in those families in which there is a marked tendency for cleft palate and harelip to appear.

Exciting Causes.—In early intra-uterine life, between the second and the third month, *the mandible, as soon as the muscles of mastication become active,*

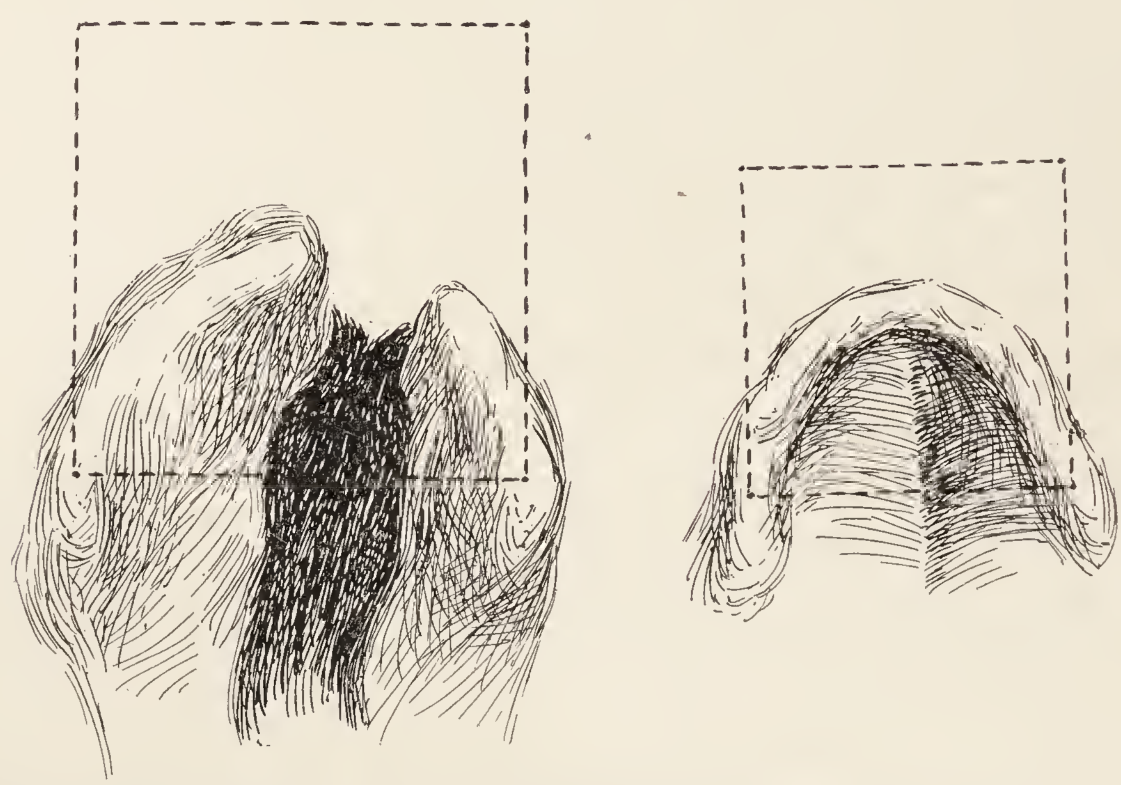


Fig. 382.—Diagram showing that a cleft palate is wider than a normal palate. It is just as much wider as the width of the cleft.

brings pressure on the palato-alveolar inclined planes of the un-united maxillary bones, and, acting as a wedge, forces them apart, thus widening the breach. Moreover, the pressure of the tongue and the flexed position of the head, with the symphysis of the mandible resting on the sternum, may contribute to some extent to the force which is exerted by the mandible on the palatal arch and thus force the bones apart. Having operated on over 3000 cleft-palate patients, approximately 1200 of whom were infants under six months, I have found that the upper jaw, in comparison with the lower, is just as much broader than it should be as is the distance between the borders of the fissures (Fig. 382). When we bring the borders of the fissure into contact, we have brought the upper jaw back to its normal breadth and to its proper relation to the lower jaw. There are very few exceptions to this statement. In young

infants, who have cleft palates, I have *always found* that by slightly forcing the chin upward, the pressure of the lower jaw against the segments of the upper jaw *will spring the cleft bones farther apart.* Authors who have given a great deal of thought to the subject and who have dwelt at great length on its etiology, those who have proposed a generous use of phosphatic food for the mother during the period of gestation, have been unconscious of the fact that *the bones are not, as a rule, defective in structure nor incomplete in development. There is only failure of union* (Figs. 383 and 384).

It will be remembered that the mandible develops from two ossific centers and finally unites at the symphysis. Failure of union would cause a fissure in the lower lip. The students of etiology of cleft palate have never explained why cleft of the mandible, with fissure in the lower lip, does not often occur.

FIG. 383.—Palatal surface of mouth of child five weeks of age showing extensive cleft of hard and soft palate and unilateral harelip.

FIG. 384.—Palatal surface of same mouth one week after operation for closure of cleft of the hard palate.

This is explained by the fact that the alveolar ridge of the mandible comes in contact with the inclined planes forming the upper arch and the elements of the mandible are thus approximated and unite. If the maxillæ met the lingual surfaces of the mandible instead of the buccal, the force exerted would cause cleft of the mandible with fissure in the lower lip.

Supernumerary Dental Rudiments as a Factor.—In 1899 Professor Warnekros published a paper, in which he noted the frequent occurrences of supernumerary teeth in congenital clefts. Since then he has published the results of a more extensive study, in which he maintains that these clefts are due to rudiments of supernumerary teeth (Figs. 385 to 388). He has modified his former view, that cleft palate is caused by failure of the maxillæ and intermaxillary bones to unite and he now believes that the cleft originates in the intermaxillary bones. It is certainly a fact that supernumerary dental rudiments have been observed by various investigators without attracting especial attention (Figs. 389 and 390.)

Warnekros presents, in support of his theory, serial sections showing that the tooth rudiment always precedes the bone rudiment in cases where the supernumerary teeth appear atavistically. Serial sections of an embryo 8 cm. in length show the rudiments of the normal lateral incisors already

Fig. 385.

highly developed at a time when ossification of the premaxillary bones had not yet been completed. This theory agrees with the position maintained by Albrecht and others that the incisor teeth were originally six in number; thus a supernumerary lateral incisor would be a reversion to type.

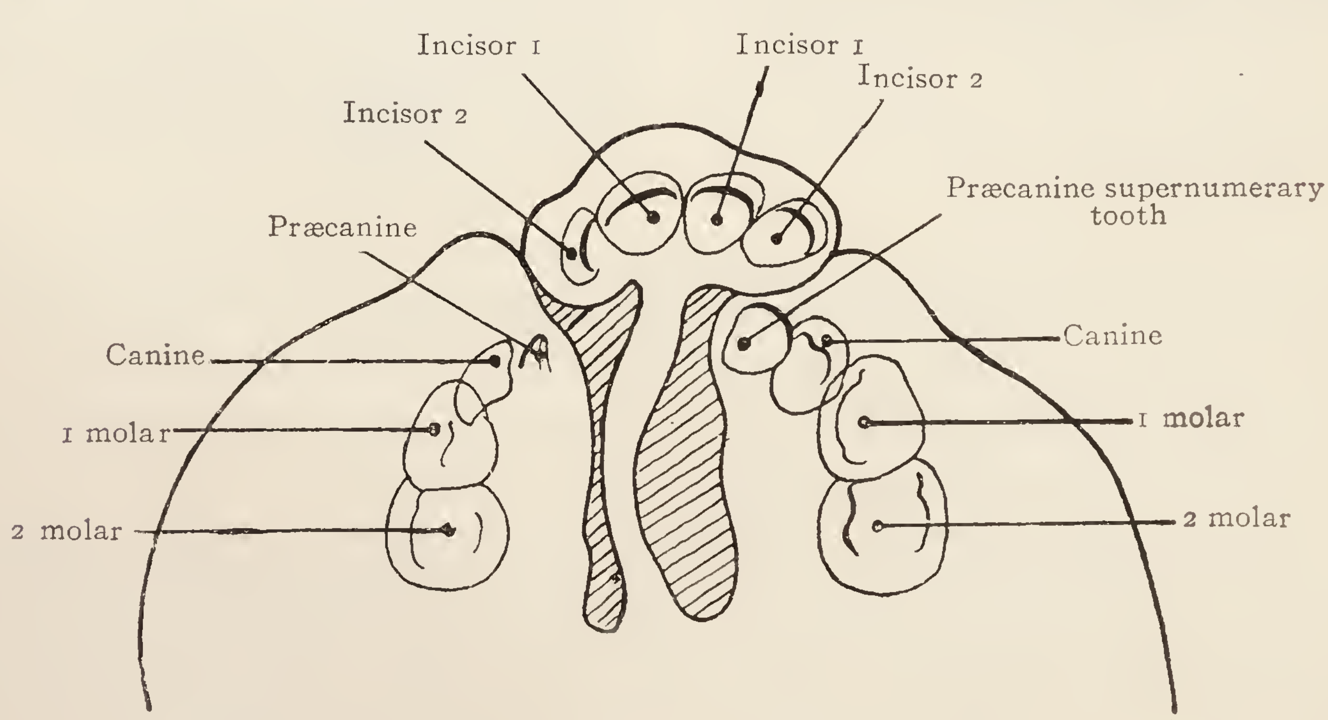


Fig. 386.

Warnekros explains the relation of heredity by maintaining that in families where cleft formations are found, it is always possible to discover a tendency toward the development of supernumerary teeth. He has confirmed this in a number of cases.

Dr. M. H. Cryer, in his work on "Studies on the Internal Anatomy of the Face," speaking of the relation of the two jaws, states: "Various theories have been advanced for this lack of union, the most prominent, perhaps, being that of malnutrition of the parts during the time when union should take place. While agreeing that malnutrition is probably largely responsible,

FIG. 387.

the author offers as a plausible explanation of the manner of its operation the idea that as the lower jaw is formed in advance of the upper one, *when undue pressure is exerted upon it, it is forced in between the four processes forming the upper jaw, thus mechanically preventing them from coming together.* The normal position of the fetus in utero is such that the weight of the entire

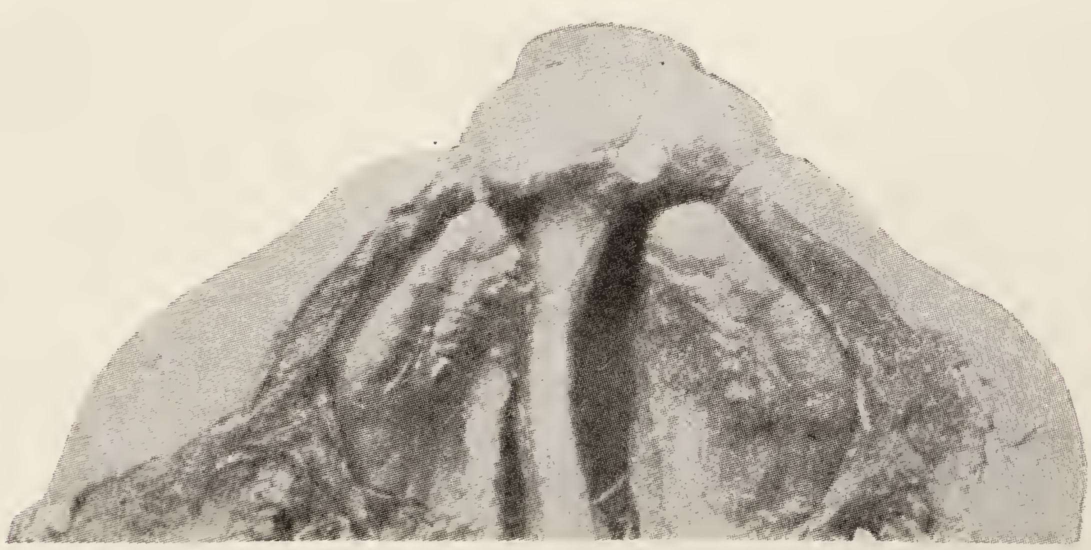


FIG. 388.

FIGS. 385 to 388.—Case 5984 shows the cleft on both sides, with the snout-like protrusion of the lip and the cleft intermaxillary bone; the skiagram and diagrammatic view demonstrate that the cleft is intra-incisive, and there is present on each side of the double-sided cleft a precanine supernumerary tooth. (*Warnekros.*)

fetal body may be readily thrown upon the vertex, and the pressure thus exerted would *tend to force the mandible into contact with the sternal region and compress the forming jaws together.* The relatively advanced development of the mandible, as compared with that of the forming maxilla, would, under the circumstances referred to, and especially in cases of low nutritional stand-

ard, interfere with the normal closure of the branchial arches and tend to produce a permanent coloboma. If an examination be made of a young child with a complete cleft, it will be noticed that the upper alveolar ridge is im-

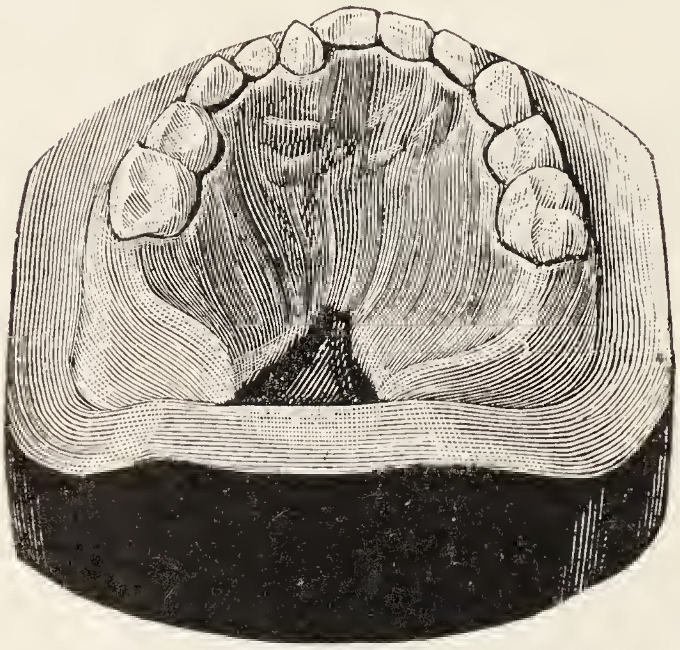


FIG. 389.—Plaster cast of a cleft palate patient who has a supernumerary cuspid tooth. (*Warnekros.*)

FIG. 390.—A plaster cast of a cleft palate patient who has a supernumerary lateral incisor tooth. (*Warnekros.*)

mediately over the alveolar ridge of the lower jaw, or it may be slightly external to it (Figs. 391 and 392).

It is generally accepted that the lower jaw acts as a matrix or mold upon which the upper jaw is formed. Certainly to an extent it becomes the mold

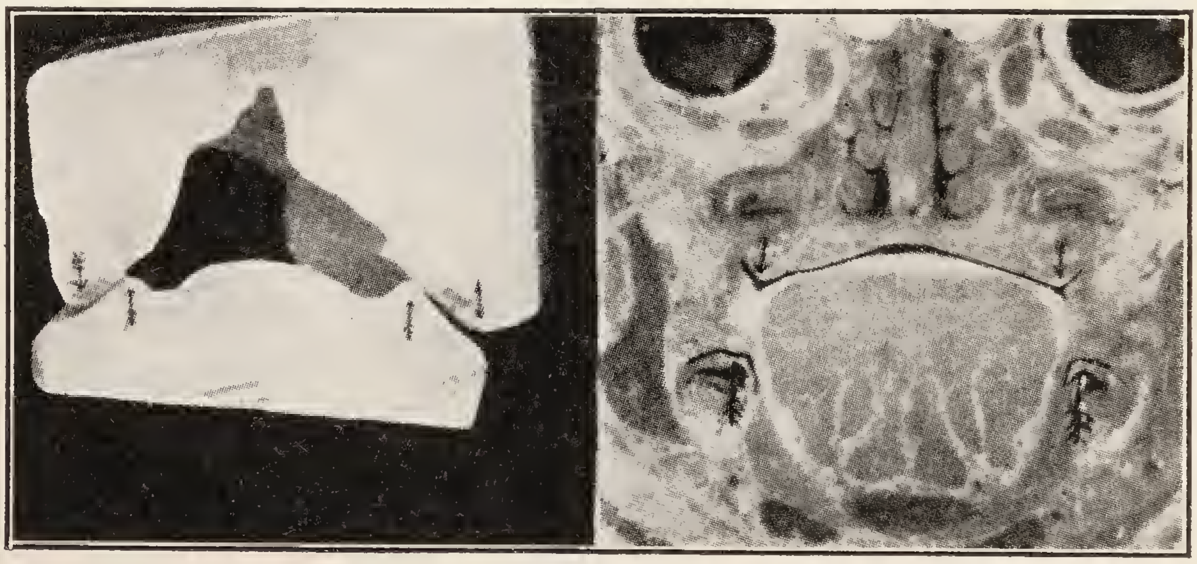


FIG. 391.—A study of the relation of the lower jaw and the tongue to a normal, and to a cleft palate. The normal palate is illustrated by a coronal frozen section, the cleft by a coronal section of a plaster reproduction of a single cleft palate. The arrows point to the alveoli in both sections. Notice that in the normal palate the lower jaw is slightly wider than the upper and that in the cleft palate the lower jaw has risen up and is wedged in between the two halves of the maxillæ. In the normal palate section the mouth is partially open. (*Blair, Dental Era, about* 1908.)

upon which the inferior border of the upper jaw is formed, as the latter comes in contact with its inner edges. This action also influences the general contour of the superior alveolar ridge and roof of the mouth. Fig. 393 is a

picture taken from the skull of a fully developed fetus. The skull has been cut *vertically and transversely* in the region of the developing deciduous teeth

FIG. 392.—*A*, Cast of complete cleft palate in an infant showing relation of upper and lower jaws. The upper is wider than the lower, causing the latter to act as a wedge constantly separating the segments of the upper jaw. B, same model after operation. This shows that the cleft has been closed moving the bones together, thus establishing the normal relations.

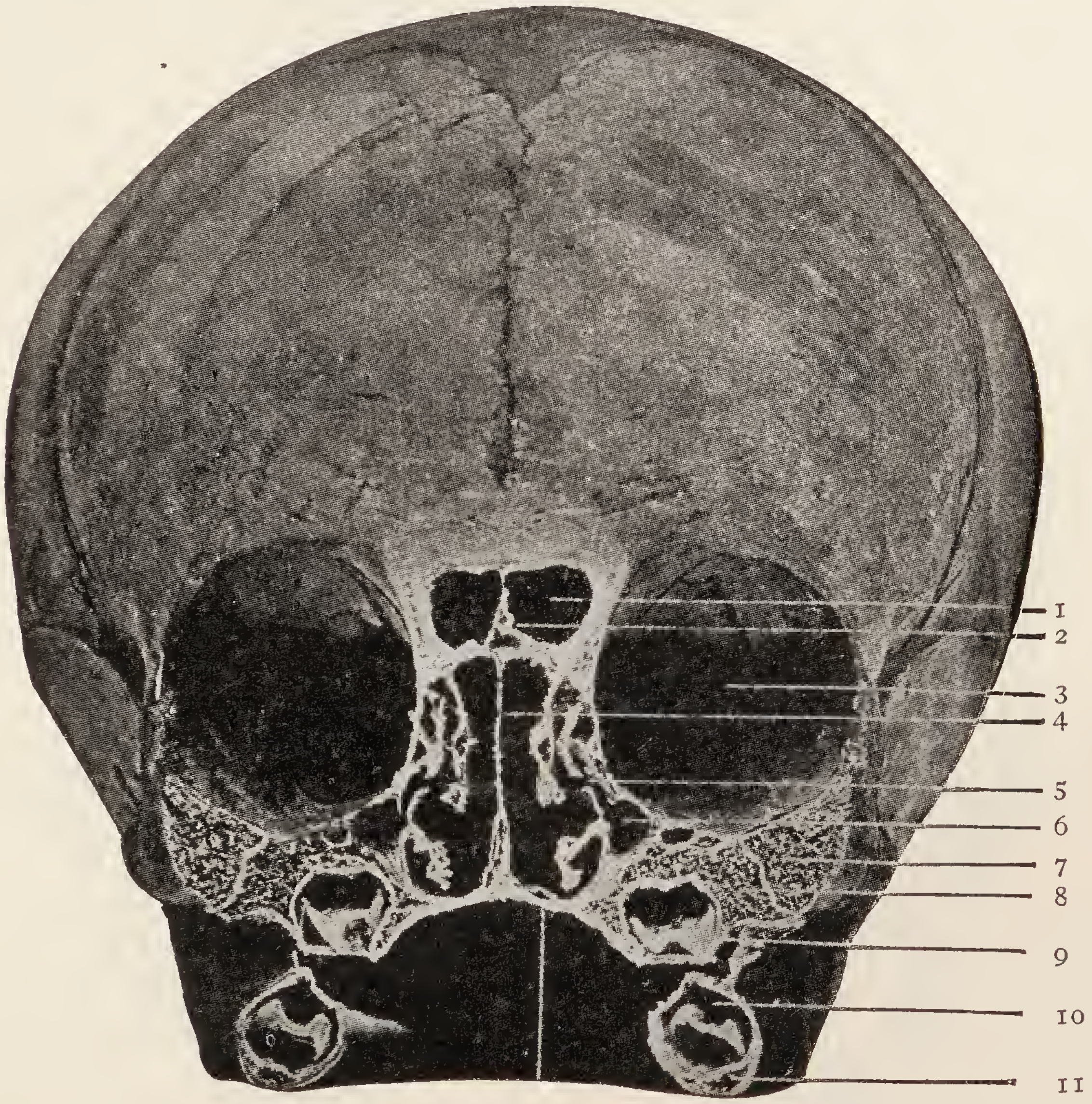


FIG. 393.—Skull of a fully developed embryo cut vertically through the first deciduous premolars. 1, Anterior fossa of brain-case; 2, crista galli; 3, orbit; 4, nasal septum; 5, osteum maxillare; 6, maxillary sinus (antrum); 7, malar bone; 8, maxilla; 9, dental germs; 10, mandible; 11, hard palate. (*Cryer.*)

of both jaws, showing the jaws in transverse section. The skull is quite symmetrical. It is plainly to be seen that the width of the upper jaw is much

less than that of the lower. As a further evidence of this fact, if vertical lines are drawn through the center of the tooth-germ and the alveolar process of

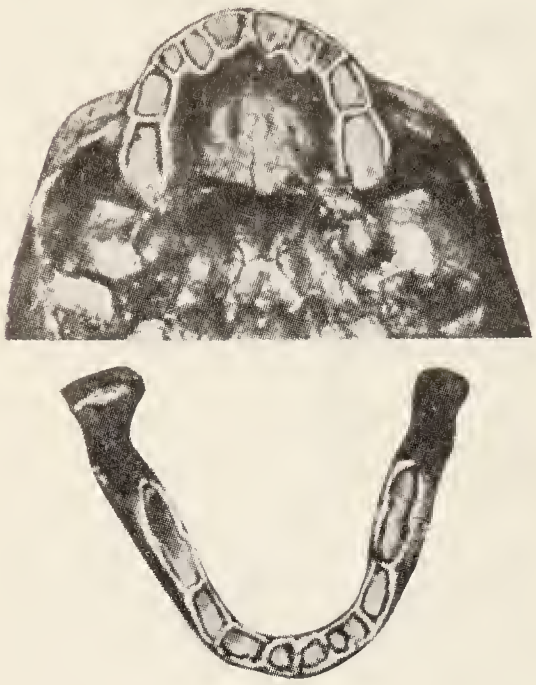


FIG. 394.—This shows the relation of the upper and lower jaws at birth. It will be noted that the mandible is wider than the maxilla. (*Harrison.*)

FIG. 395.—Anterior view of a vertical transverse section through the lower jaw and the lower portion of the upper jaw. (*Cryer.*)

each jaw, it will be found that the lines of the upper jaw are on the inner side of those of the lower jaw, the extent of the difference being about one-half

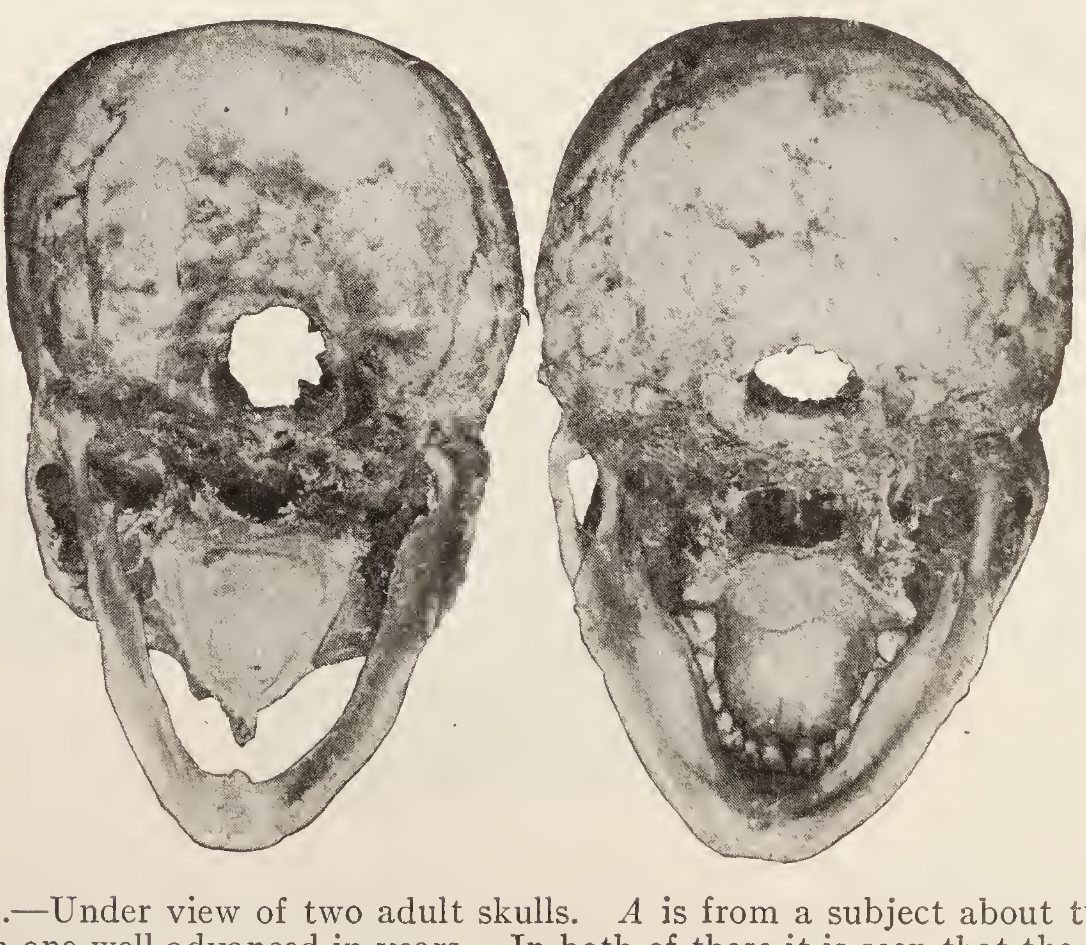


FIG. 396.—Under view of two adult skulls. *A* is from a subject about twenty years old; *B*, from one well advanced in years. In both of these it is seen that the mandible is very much wider than the maxillæ. (*Cryer.*)

of the thickness of the lower jaw. Fig. 395 is taken from an adult jaw. If the lines be drawn through the axes of the upper and lower teeth, it will be

found that those through the upper teeth, as they extend through the coronal surfaces, pass a little outward, while those passing through the lower teeth incline inward. This is evidence that the relation found in the fetus has been continued and that all through the period of growth of the lower jaw and development of its alveolar process, the latter has been directed inward, while the upper alveolar process has extended outwardly so that the cusps of the upper permanent teeth, when fully developed normally, bite over the outer cusps of the lower teeth occluding with them. *If the teeth and alveolar process be excluded, it will be observed, as in the fetal skull, that the upper jaw is much smaller than the lower.*

In the young adult the upper alveolar ridge is in vertical line with that of the lower. In one of advanced age the mandible is a great deal broader than the maxillæ (Fig. 396).

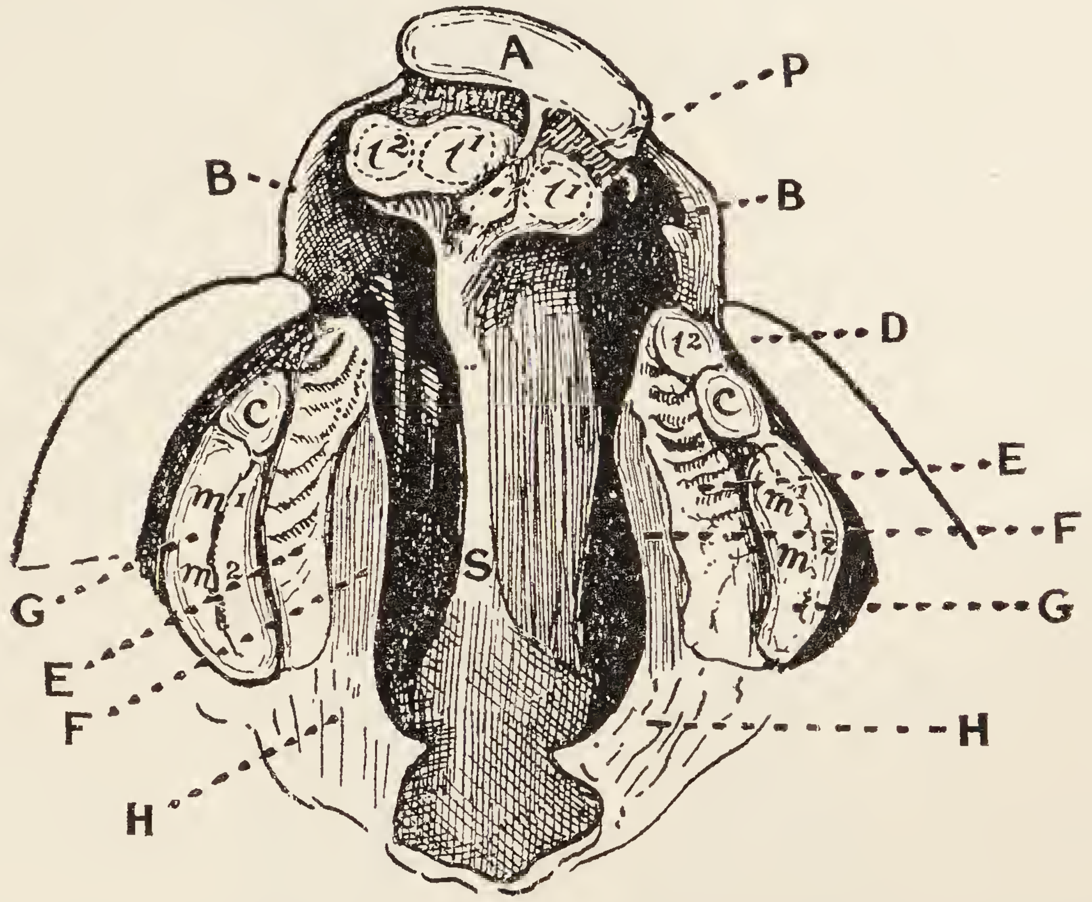


FIG. 397.—Tripartite palate. *A*, Median part of upper lip; *B*, *B*, alæ of nose (two tags on left); *C*, canine tooth buds; *D*, lip; *E*, rugose part of palate; *F*, marginal part; *G*, alveolar part; *H*, soft palate with uvular process; l^1, l^2, incisors; *P*, incisive papilla; *S*, septum. (*Keith.*)

In a very interesting article Prof. Arthur Keith[1] makes the following statement: "In 555 cases at the clinic of von Bruns at Tubingen, Dr. Gustaf Haug[2] found that the tripartite palate occurred in fifteen per cent. against

[1] Arthur Keith, M. D., British Medical Journal, Aug., 1909, on Congenital Malformations of the Palate, Face, and Neck. In this connection, I wish to express my appreciation of the great kindness shown to me by Dr. Keith in exhibiting large and valuable collections of congenital deformities, including cleft palate and harelip, in the Museum of the Royal College of Surgeons.

[2] Beitrage f. Klin. Chir., 1904, BB. 44, p. 254.

thirty-eight per cent. in the London series, bipartite palate in twenty-three per cent. against twenty-two per cent. in the London series; and unilateral harelip with no cleft of the palate, forty per cent. against nine per cent. in the London series. In tripartite palate, which must be regarded as the most severe form, the three elementary parts of the palate are widely separated. In all cases the lesion is remarkably alike, a typical example being shown in Fig. 397 In the middle element from before backwards are to be recognized (1) the middle part of the upper lip, (2) the premaxillary part of the palate, carrying the incisor papilla which is joined to the upper lip by a fraenum, (3) the lower border of the septum of the nose, which is wider, shallower and longer than the normal, (4) the varying number of dental sacs on the premaxilla. In sixteen cases only the two middle incisors are carried, in three cases one lateral incisor as well as two middle (as in the specimen shown in Fig. 397, and in four cases all four incisors. In none did the premaxilla show a suture between the ectognathic and the mesognathic part. The nerves and vessels of this element are the naso-palatine. On each lateral or maxillary element, three distinct areas can be recognized: (1) the alveolar area on which may be seen an elevation over the sacs of the two milk molars, another over the canine and, frequently, a third often on the margin of the cleft over the lateral incisor; (2) a plicate or rugose area marked by folds; (3) a smooth, narrow marginal area (Fig. 397). When the mucous membrane is removed, the maxillary or lateral element is seen to be supported by the superior maxilla and palate bones. The nerves and vessels of the maxillary elements are the descending palatine."

Table 1.—Classified List of Specimens Showing Congenital Clefts of the Palate and Upper Lip in Metropolitan Medical Museums

	A	B	C	Total
1. Palate cleft into three parts	14	12	2	28
2. Palate cleft into two parts	3	12	2	17
3. Median cleft extending from the premaxilla to the uvula	4	3	7	14
4. Cleft of soft palate	3	0	0	3
5. Cleft of uvula	4	1	0	5
6. Cleft on both sides of premaxilla	1	0	0	1
7. Cleft limited to one side of premaxilla	1	0	1	2
8. Median cleft due to absence of premaxilla	1	2	4	7
9. Bilateral harelip	1	0	3	4
10. Unilateral harelip	0	6	0	6
11. Median harelip	0	0	0	0
	32	36	19	87

A. Specimens in the Museum of the Royal College of Surgeons of England.

B. Specimens in the museums of metropolitan medical schools.

C. Specimens of cleft palate in mammals other than man, chiefly in the Museum of the Royal College of Surgeons of England.

The Degree of Separation between the Various Parts of the Palate.—Professor Keith further states that "The late Professor His was of the opinion

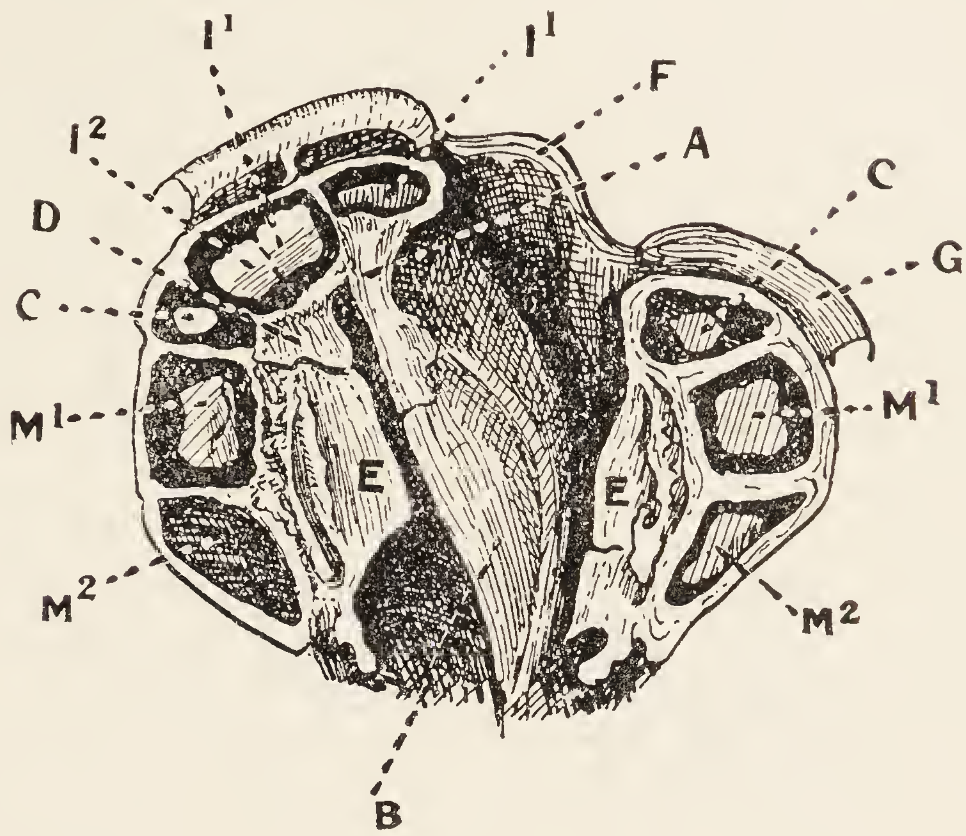


FIG. 398.—Bipartite palate. *A*, Septal process of premaxilla; *B*, vomer; *C*, canine; *D*, premaxilla; *E*, marginal part of palate; *F*, ala of nose; *G*, maxillary part of lip; l^1, l^2, incisor teeth; M^1, M^2, milk molars. (*Keith.*)

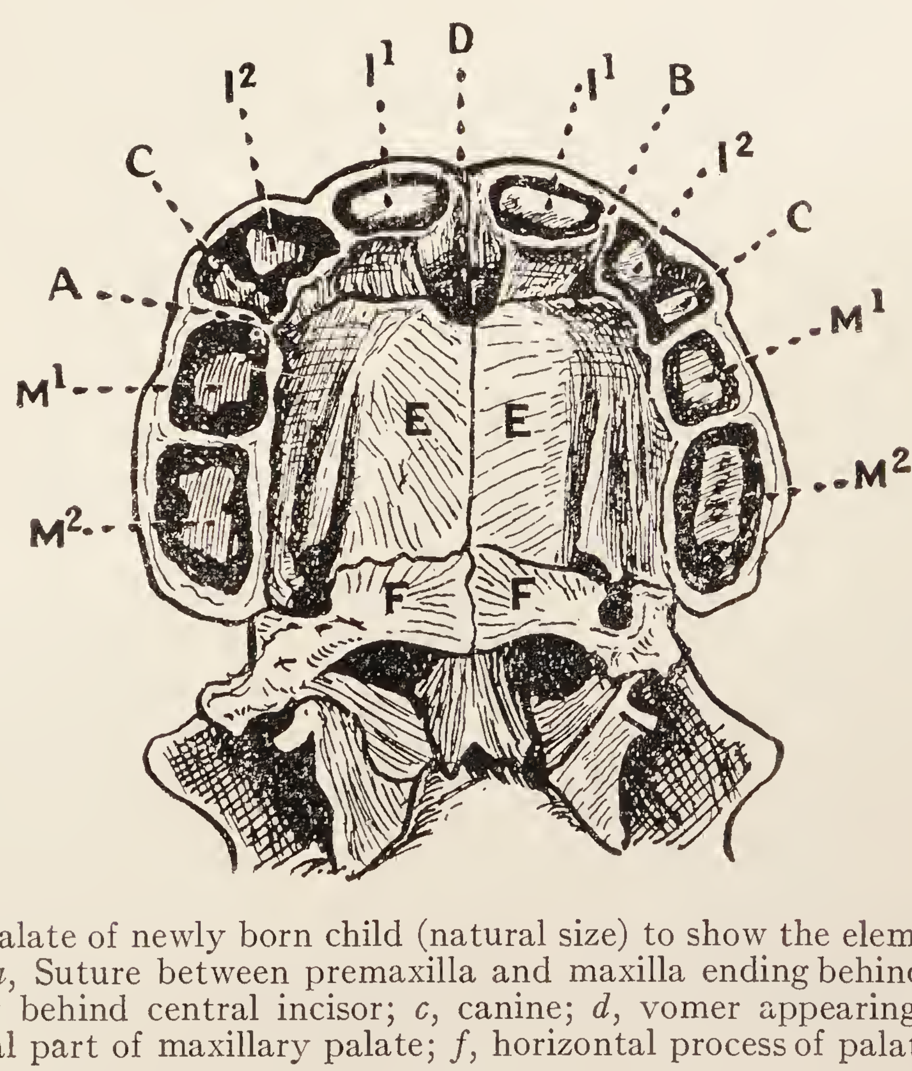


FIG. 399.—Palate of newly born child (natural size) to show the elements entering into its formation. *a*, Suture between premaxilla and maxilla ending behind canine tooth; *b*, the same ending behind central incisor; *c*, canine; *d*, vomer appearing in naso-palatine fossa; *e*, marginal part of maxillary palate; *f*, horizontal process of palate bones. (*Keith.*)

that cleft in the palate resulted from irregular and in-coördinated growth of the three elements which go to form it. That the growth of the three parts

is irregular in the latter months of fetal life there can be no doubt. (See Figs. 371 and 397). The septal part of the mesial nasal process is abnormally long so that the premaxilla projects some 6 to 8 mm. in front of the maxillary part of the palate. The increase in length of the septum is due not to the vomerine part of the septum, but to that part of it which is formed by the premaxillary part of the process (Fig. 398). If the premaxilla becomes adherent to the maxilla on one side, the extra growth of the septum still takes place, with the result that the premaxilla is bent towards the side on which union takes place (Fig. 371). Irregularity of growth is not the cause, but the result, of the cleft condition. From the evidence to be produced, it is probable that the processes which form the palate were in contact during the fifth and sixth weeks of development, but, for some reason, the exact cause we do not know, union did not take place then. The union of the embryological processes is comparable in every way to the healing of wounds; the epithelial coverings on each side of the nasal groove come in contact and form a bridge across which the uniting mesoblasts may grow. If, for some reason, union is delayed—and from Professor Mall's observation there can be no doubt that uterine inflammations, sometimes from syphilis, is the most common cause—growth in the several elements of the palate causes them to separate, and once the breach in their continuity has been effected, union cannot take place afterward. The younger the fetus, the smaller the cleft, not only absolutely, but relatively. The width of the fissure between the palatal processes of the superior maxilla varies from 7 to 20 mm. in the tripartite palate; 14 mm. is the average in eight full term children; in a fetus of the fourth month this cleft measured only 1 mm.

Brophy has suggested that the subsequent separation is caused by the pressure of the lower jaw and tongue against the palate. The material at my disposal is in harmony with his suggestion. He also makes the statement that there is no atrophy of the parts that go to form the palate, but this is certainly not the case in the specimens that I have examined. In three palates of adults the cleft was on the average 20 mm. wide, the breadth of the palate 64 mm. The bony parts of these palates were thus 10 or 15 mm. less than normal.[1] In newly born children the deficiency affects the inner or marginal area of the palate (Fig. 397), but it does not amount to more than 3 mm. on each side. Whether the cleft continues to increase after birth, I am not in a position to say, but, judging from the width of the cleft in the adult palate, I conclude that the parts do not continue to separate after birth at the rate they did before birth.

Imperfect Degrees of Union.—In Fig. 400 there are shown very imperfect strands of union between the premaxillary and maxillary processes. A study of these throws much light on the condition of cleft palate. The slightest degree of union is shown in Fig. 400, *A*, where a strand of fibrous tissue

[1] See paragraph 2, page 592.

covered with epithelium unites the ala of the nose to the premaxillary process. This represents the rudiment or, rather, vestige of the union of the mesial and lateral nasal processes to form the boundary of the anterior nares. In b, c and d, Fig. 400, increasing degrees of union are shown. In the fullest degree the uniting band forms a bridge on which four elements end in attempting to reach the premaxillary process—(1) the ala of the nose, (2) the lateral part of the upper lip, (3) the dental groove, (4) the palatal process of the upper maxilla. These strands of union have become stretched, apparently, by the unequal or irregular growth of the parts which go to form the palate or upper lip. Occasionally blunt conical processes occur on each side of the cleft, evidently the remnants of a strand which has broken under the strain."

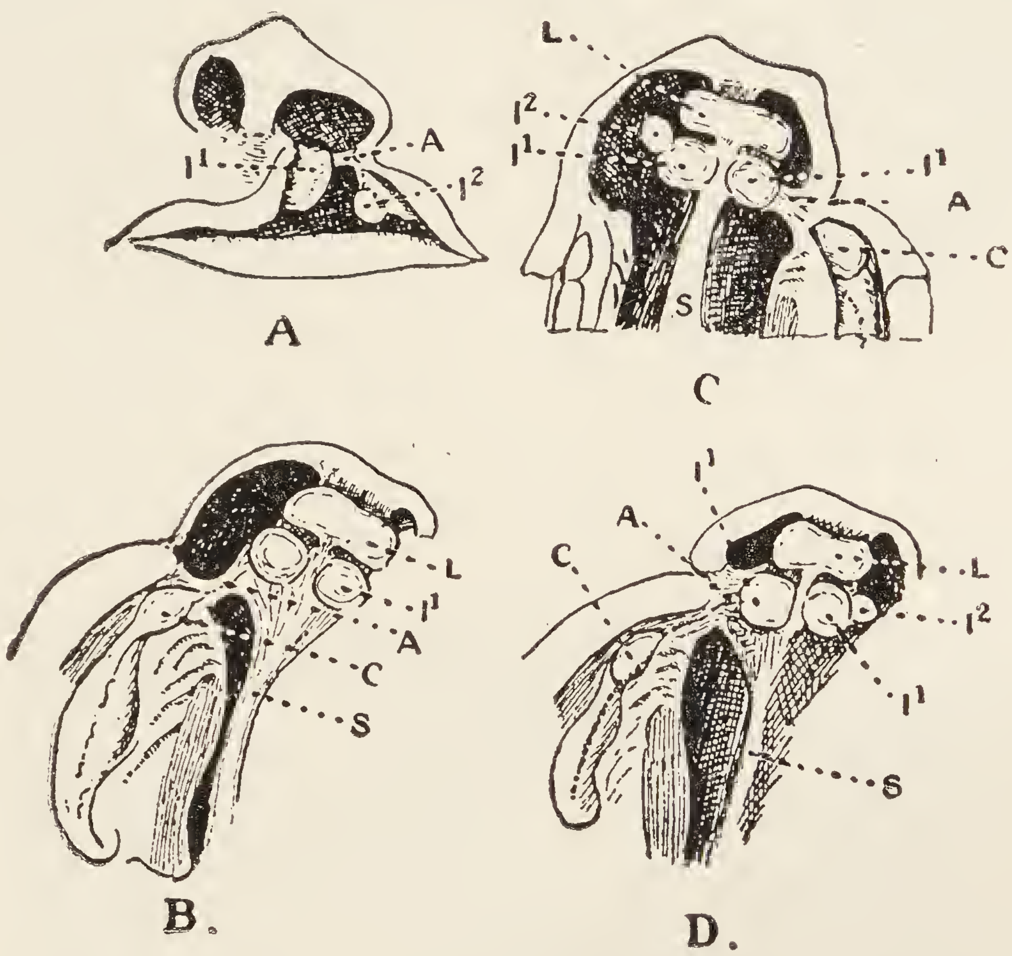


FIG. 400.—Four specimens of cleft palate showing various degrees in the development of the band between the premaxillary, maxillary and lateral nasal elements. *A*, The bond or bridge of tissue crossing the cleft; l^1, central incisor sac; l^2, lateral incisor sac; *C*, canine sac; *L*, median part of upper lip; *S*, septum of nose. (*Keith.*)

In a previous paper[1] I made the following statement: "If the muscles are very early brought into action, they develop instead of atrophy, hence a good velum is secured, with plenty of tissue; whereas, if the operation is undertaken later in life, the parts are undeveloped through non-use and they cannot so easily be made to subserve the same purposes that tissues, which develop through natural employment, can be made to do." It will be seen that I have not said "there is no atrophy of the parts that go to form the palate." I hold that *at birth* the normal quantity of tissue is nearly always present. Later in life these parts, if not united by early surgical operation, may fail to develop. This condition may easily lead the observer to conclude

[1] Read before the American Surgical Association at St. Louis, Mo., in 1904.

that there has been atrophy of parts, although the fact exists that they have not been put to use and, therefore, may not have grown in proportion to the tissues which *are* in use.

In a personal communication bearing upon the condition of complete cleft palate in infants, Professor Keith writes: "I agree with you that *in the majority of cases of complete cleft of the palate, there is no deficiency of tissue at birth nor for some time after birth. I also agree that the cleft, however wide, is not due to a deficiency of tissue in the several elements which go to form the palate, but is entirely due to the fact that when the various embryonal parts or elements are developed and come together in the second month of development, the process of union, which should occur then by a means similar to union by first intention, is delayed and does not take place, hence the several palatal elements, being in-coördinated by union, tend to separate as growth occurs, the cleft increasing during each month of growth. The exact cause of the separation of the parts and the enlargement of the cleft is probably due to several factors, tongue pressure, muscle traction and also the independent process of growth in each individual part.*[1] Theoretically, the best treatment ought to be to bring about union at the very earliest date, but theory and practice may not be easily harmonized. To lay down the lines of treatment is beyond my province and my experience. I simply note the fact that three men whose opinion I value—yourself and Arbuthnot Lane on the one hand and James Berry on the other—have reached diametrically opposite conclusions as to which is the best time to operate. Still, that does not influence me in agreeing with you that to secure a good palate *the sooner the cleft is remedied in complete cases, the better the result ought to be.*" I regard the statements of Dr. Keith as further proof of the declaration made by me many years ago, that *cleft palate is not the result of arrested development or insufficient tissue to form a normal palate,* the views of many authors to the contrary notwithstanding. I am sure that anyone interested enough to enter into a careful investigation of this subject, no matter what his previous opinions may have been, will be convinced that *at birth a cleft palate, with rare exceptions, has in it sufficient tissue to form a normal palate and that the abnormality is only a separation of well-developed parts.*

Condition of Cleft Palate in the New-born.—As to the condition in the new-born child, we find these parts not only separated, but the plates forming the hard palate are elevated to a considerable extent by the pressure of the mandible and tongue (Fig. 401), and that elevation naturally moves the separated edges farther apart than in the vault of normal height (Fig. 402). To establish a law in connection with the subject, a great many specimens must be examined. I am convinced that an accurate measurement of the palatal surfaces of the separated bones will show that the distance between the borders of the cleft and the center of the alveolar processes presents as broad a surface as will be found in the bones of a child of the same size,

[1] Italics mine.

whose palate is normal. Further, to repeat what I have stated previously *the upper jaw is just as much wider than it should be, as the distance between*

Fig. 401.

Fig. 402.

Fig. 401.—Vertical section of cleft palate, infant's head, showing the enormous breadth of the upper jaw and nares. The upper jaw is as much wider than the lower as the distance between the border of the fissure. (*Stone.*)

Fig. 402.—Vertical section of normal infant's head showing the relation of the lower to the upper alveolar borders. The upper and lower jaws are of the same width.

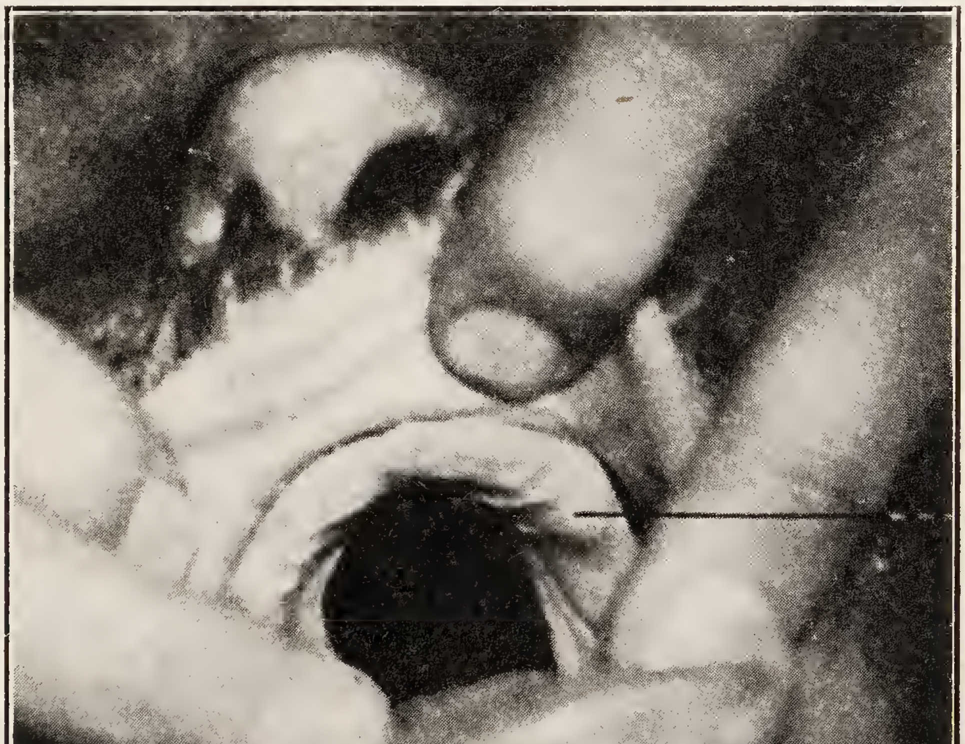


Fig. 403.—Cleft palate with absence of horizontal plates from palate bones in an adult usually regarded as inoperable. Blair's operation, however, by reflecting the flaps from the neck may close the fissure. (*Carmody.*)

the borders of the cleft. When, by reason of the pressure of the tongue and mandible against the alveolar inclined planes, the separated bony plates

are carried upward to an extreme height and laterally, the distance, naturally, is greater, as illustrated, than it would be if these plates were in their normal position. I am aware that occasionally we find an absence of nearly all of the hard palate (Fig. 403). This is not the result of atrophy, but of failure of development of the bones. These cases are extremely rare, however.

Relation of Incisor Teeth to the Cleft.—In the very careful study that Professor Keith has given this subject, he has brought statistics of inestimable value to the attention of the profession. He has pointed out, in the study of the relation of the incisor teeth to the cleft, that the cleft usually lies between the central and lateral incisors. In doing this, he has set aside the view held by some authors that the cleft is almost invariably between the lateral incisor and the cuspid teeth. He states that out of forty-three cases twenty-three showed the fissure passing between the central and lateral incisors, in nine it passed between the lateral incisor and cuspid teeth, and in seven cases the lateral incisors had not developed on the sides of the fissure, while in two a third incisor, or supernumerary tooth, was developed. The teaching of Albrecht, who endeavored to explain the varying relations of the fissure to the incisor teeth, presumes that the premaxillæ are developed in two parts, one part carrying the central incisors and the other the lateral incisors. It was shown by Koeliker and His that Albrecht was wrong in his conclusions that the lateral nasal process did not enter into either the palate or the lip. We know that occasionally premaxillary bones are divided in such a way that there are four parts instead of two, but this condition is not constant.

Bipartite Palate.—Professor Keith, in describing the bipartite palate, or palate having only a single defect of the anterior part, separating the premaxillary from the maxillary bone on the one side while, on the other, union is complete, states that out of fifteen cases the cleft passed to the left in eleven. Haug found it on the left side in 149 cases out of 216. My own experience would give the cleft on the left side in a very much larger per cent. of cases. The question has never been settled as to why the cleft occurs with more frequency on the left side.

Intermaxillary Clefts.—In regard to the intermaxillary clefts, Professor Keith says: "As we have seen, the union of the premaxillary element with the alveolar parts of the maxilla marks a distinct stage in the evolution of the palate, a stage well seen in amphibians. The next stage—the mammalian—lies in the development and union of the maxillary palatal processes already to be seen in the amphibian palate. One would expect arrests to occur in the passage from the amphibian to the mammalian stage, although such specimens are comparatively rare in museums (of the fourteen cases on my list, seven are from the human subject, the others are from the dog, lion, sheep and calf); they are the more common form of cleft palate met with in practice. Mr. J. Berry records a list of sixty-seven cases, of which thirty-six were due to non-fusion of the maxillary processes in the roof of the mouth. In these

cases there is a real arrest, not only of the fusion of the processes, but of their actual growth.[1] Clefts of the soft palate alone or of the uvula alone, as may be seen from Table 1, are comparatively rare. I have seen three of the former

FIG. 404.—Cast of anterior half of adult cleft palate showing abnormally high arch.

FIG. 405.—Cast of posterior part of same cleft.

and five of the latter. They indicate an arrest towards the end of the development of the palate when the fetus is about 50 mm. long and entering the

[1] The extreme height of the separated hard palate and the corresponding breadth of the cleft presents an appearance of absence of tissue. If the elevated hard palate were lowered to its normal position it would be quite wide enough to close the fissure (Figs. 404 and 405).

third month of intra-uterine life. Even when the palate is completely cleft the two halves of the uvula are clearly indicated as tags projected from the borders of the palatal folds. The dissection in the College Museum show the tensor and levator palati muscles well developed; the upper parts of the superior constrictor and palato-pharyngeal muscles are stronger than in normal palates."[1]

Among the many causes that have been assigned for failure of union of the palate within the first two months of embryonal life, the one advanced by the late Dr. C. F. W. Bödecker of Berlin is, I believe, most to be relied upon. It is based upon physiological and anatomical grounds. We know that in the formation of the teeth, the mucosa dips deep down into the submucous tissue, forms the epithelial lamina, which contracts into the epithelial cord at the distal end of which the enamel organ is formed. It is too well known to admit of discussion that a layer of epithelium under certain conditions will form an obstruction to union of the tissues between which it intervenes. The illustrations (Figs. 373 to 380) exhibited clearly present the passage of epithelium deep into the connective tissue in the enamel formation. It seems that Bödecker's conclusions, namely, that this epithelial cord delays union of the parts forming the superior maxillæ and, by reason of the force exerted by the tongue and mandible from the beginning of the third month until birth and several months later, accounts for the broad separation of the maxillary bones and the creation of cleft palate.

Early Symptoms.—A new-born child, having a cleft palate, usually weighs more at birth than it will a few weeks later. The loss of weight is due to defective deglutition and nutrition and, not infrequently, to improper food. Lack of knowledge regarding infant food and feeding is very common. In the absence of harelip, the deformity of cleft palate is often not discovered for several days—sometimes weeks. This is a great oversight on the part of the obstetrician and nurse. It is the duty of the attending physician *to make a careful examination of every child the day it is born* to discover possible defects or abnormalities of any nature. An examination of the mouth having been neglected, the first indication of a cleft is difficulty in swallowing and regurgitation of food through the nose. Consequently, the child is irritated and distressed by its inability to receive proper nutrition. It develops gastroenteritis, loses weight, becomes emaciated and many die of starvation.

Symptoms in Adults.—The symptoms of cleft palate in patients later than in infancy, when accompanied by harelip are easily recognized, though the casual observer might easily be misled in assuming that one who has harelip also has cleft palate, since these deformities are not always associated. Those who have perfect lips and defective palates sometimes speak quite well, while many who have perfect lips and perfect palates speak with the nasal intonation which characterizes a cleft palate. The voice, therefore, is not an infallible symptom. An ocular examination quickly reveals the condition

[1] Hence the value of these muscles in lengthening short palates (see page 709).

of the parts. Patients having cleft palate utter the vowels and most of the consonants distinctly. The great difficulty lies in producing the guttural, labial, etc., sounds (see Phonation).

Preparation of Patient for Operation.—The first consideration before

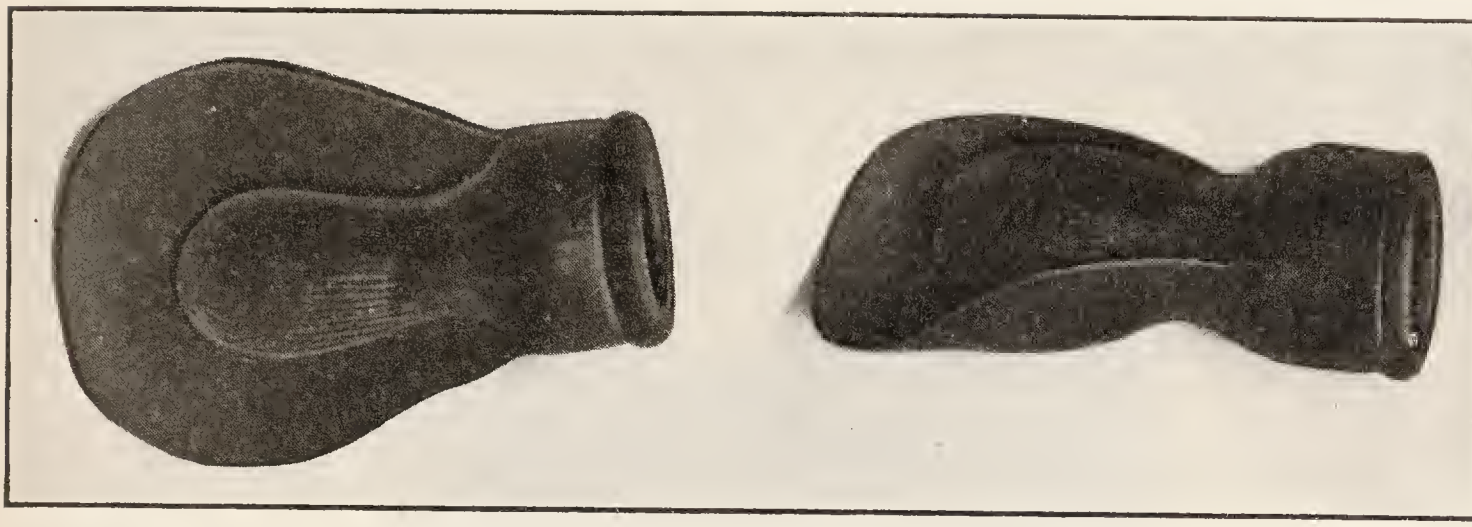


FIG. 406.—Cleft palate nipple. The flange is so constructed that the cleft is covered. This enables the infant to nurse without the milk getting into the nares.

operations is to look to the general condition of the patient. I am sure it has been the experience of every surgeon that infants who have a cleft palate are badly nourished. The open palate makes it impossible for the child to draw its milk and what little it may get often regurgitates through the nose. For this

FIG. 407.—Rubber velum used when the child nurses the breast. The mother places the velum in the child's mouth against the palate, holds it by the handle and nurses the child. This prevents the milk from regurgitating through the nose and enables the child to swallow without difficulty.

reason the child is greatly irritated and loses weight, making it a poor operative risk. Steps should be taken immediately to aid the child in swallowing its food by the use of a cleft palate nipple or velum which is employed in conjunction with the breast (Figs. 406, 407, and 856). Lawson Tait has stated that

the mortality of children who have cleft palate is so great by reason of their failure to secure proper nutrition that an early operation is desirable. Moreover, many mothers, who make use of bottles for feeding infants, have not the proper knowledge of sterilization and, as a consequence, children soon develop gastro-enteritis, which must always be cured before an operation is attempted (see page 1018). The first duty of a surgeon, on receiving a patient for operation, is to place it in the hands of a competent graduate nurse, study its physical condition, see that it is gaining weight, that all the organs of the body are performing their functions normally, that its general condition is favorable and operate only after he is satisfied that

Fig. 408.—Case of cleft palate with webbed fingers and toes and divergent strabismus.

his patient is not ill. I am satisfied that the mortality of children following operation upon the palate has been increased by reason of the fact that these things have been neglected and that the children were ill at the time of operation. A surgeon who operates on a sick child cannot hope for success. I do not assume that a surgeon would operate on a sick child knowingly, but too frequently the child is brought to the hospital by its parents and not infrequently by the family physician, who expect an operation to be made at once. The surgeon often meets with opposition on the part of the parents when he insists on delay sufficiently long to know the exact physcial condition of the child, but he must be firm. It is not only the question of feeding and diges-

tion that must be considered, as children often contract heavy colds on the way from their homes to the hospital. These colds do not manifest themselves on their entrance, but a day or two later develop to such an extent that an operation would be contra-indicated.

Complicating Defects.—Not only should the foregoing precautions be observed, but a thorough examination of the child should be made. Other congenital defects are sometimes found, a knowledge of which the parents may not have. In children which have come under my observation, I have noticed the following congenital defects associated with cleft palate: Hydrocephalus, inguinal and umbilical hernia, club feet, a supernumerary ear,

Fig. 409.—Case of cleft palate and harelip with deformed hands and feet. Child also had double inguinal hernia.

six toes on each foot and two thumbs on each hand, hypospadias, web fingers and toes (Fig. 408), three deformed fingers (Fig. 409), curvature of the spine spina bifida, absence of one eye, absence of the premaxillary bones, harelip, single and double, protruding premaxillary bones, fissures in the cheek extending from the harelip to the inner canthus of the eye, angioma and phymosis.

Patients Over Six Months of Age.—If the patient is beyond the age when transfixion of the bones is advisable, it should be just as carefully examined. The condition of the stomach and bowels should be normal, the patient well nourished, the temperature normal, the pharynx free of adenoid growths and diseased tonsils. If adenoids or hypertrophied tonsils are present, no opera-

tion on the palate should be attempted until after their removal and sufficient time allowed—about two weeks—for the parts to have perfectly healed. In older patients, an examination of the teeth should be made, and broken down, useless roots removed, carious teeth treated and filled and chronic dento-alveolar abscesses cured. The infection from tonsils, adenoids, diseased teeth, gums and the nasal passages is not only injurious to the health of the patient, but a menace to the palate operation. Pus from the nose and pharyngeal walls has often been destructive to operations on the palate. The greatest care must be observed in securing an operating field as clean as possible. The nose, mouth and pharynx should be irrigated with boric acid or normal salt solution three times a day for two days, at least, before operating. Heart, lungs, urine and blood should be examined, as the surgeon should know their condition. A cathartic should be administered the night before operation and a colonic flushing given in the morning. No doubt the morning is the most desirable time for any operation, as the surgeon, rested from his work of the previous day, is in the best form to operate. The patient also has rested through the night and those old enough to give thought to the approaching operation are spared not only the hardship of fasting, but the mental distress which many experience from the hour of awakening to the moment of unconsciousness. Such distress, in nervous patients especially, is often extreme. For further details in the preparation of the patient, the reader is referred to page 170.

Operating Room.—Next in importance to the proper preparation of the patient is the operating room, the lighting of which, for surgery of the mouth, nose, trachea or esophagus, as we usually see it, is by no means satisfactory. Large sky-lights and side lights are not suitable for the lighting of the parts above mentioned. Having made use of every kind of daylight, I do not hesitate to assert that such lighting is most unsatisfactory. Neither has the use of an electric headlight, in my own experience, come up to my expectations.

Realizing that the usual lighting of the dentist's operating room was very defective, I prepared a paper on the subject of "Light."[1] Its aim was to correct the misuse of light as applied to dental operations. The notion is possessed by many practitioners of excellent repute that a large window, with a great volume of light entering it, is essential to the highest degree in operating. I pointed out the error of such views, and that the most perfect light for operating required dark green or brown walls and ceiling which would not reflect light, but absorb it. The windows should be so shaded that rays of light will be directed upon the field of the operation. Such is the most perfect light for the practice of operative dentistry. The same general principles apply to the practice of surgery. Hospital construction and modern ideas of perfect sanitation have led surgeons to cause their operating rooms to be

[1] Read at a meeting of the Chicago Odontological Society, Dental Review, v.5, p. 294, 1891.

built with enormous sky-lights, with walls painted with white enamel or made of white tile. Walls so constructed reflect light with a brilliancy second only to a mirror. The glare thus produced, with the reflection from the white linen surrounding the operator, interferes with vision and must necessarily, in the course of time, seriously injure the surgeon's eyes. It makes his work more difficult to perform and thus less efficient. The best lighting that can be secured would include the darkened walls of the operating room and all linen to be dark green or brown in color.

The Ideal Light.—The ideal light for palate operations is the electric light made up of two circles of incandescent lamps of fifty candle power, as now provided in the best equipped hospitals. The first circle should be about thirty inches in diameter and the second forty-eight inches, with a suitable reflector overhead, thus flooding the patient's face and mouth with direct rays of light. We not only have an abundance of bright light directed into the mouth, but the circles of light are so adjusted that the casting of shadows by the surgeon's hands while operating is impossible. All daylight should be excluded by the use of shades. The mixture of daylight and artificial light is very objectionable, as the field of operation cannot be illuminated properly.

I have not found it essential to secure a special operating table. The ordinary table, as found in the better hospitals, serves every purpose. The remaining equipment should consist of a large instrument table and a smaller bracket table, one which can be suspended over the operating table. The sterilizing apparatus, etc., should be such as is found in the well-equipped hospital.

Assistants.—The anesthetist is of the greatest importance and he should be so trained that he will not need the surgeon's guidance. The first assistant should also be so well trained that he will anticipate every want of the operator. He should stand at the left of the table and make use of the long forceps to pick up the sponges lying close at hand. He clears the throat and sponges the parts as frequently as may be necessary. He should see that all the instruments needed are sterilized and placed on the table. I might say, in passing, that this assistant should also see that the instruments are kept in perfect order. It is the surgeon's duty, when performing an operation, to be as expeditious as thoroughness will admit. To do this, he must not be required to direct the work of the anesthetist or to take the time for threading needles, handling wires, procuring sponges or any other material employed in the operation. The second assistant is really an assistant to the first, to take orders from him and aid in doing his work. These assistants may sometimes make use of the tenaculum or forceps, thus aiding in the introduction of the sutures. The nurse should be constantly at hand, keeping the instruments clean and supplying the necessary sponges. I have not found it necessary or convenient to use rubber gloves in operating on cleft palate. The hands are thoroughly scrubbed with green soap and water and rinsed in alcohol and bichloride solution.

Position of the Patient on the Table.—The patient is placed on the operating table and, by the use of a bandage, which is fixed to one wrist, carried under the body and fixed to the other, his hands are secured close to his sides, held firmly and thus kept quiet. Straps and buckles, with suitable wristlets, are now made to serve this purpose. In Germany, young children are put in leather wrappers and so securely fixed that their hands cannot possibly be raised to interfere with the work of the surgeon. The patient's head should be protected either by a bathing cap or a towel so that the operator's hands cannot come in contact with it. The cap also prevents the hair from being soiled or covered with blood. The anesthetist sits at the head and to the left of the patient, leaving the place to the right for the surgeon. The table should be high enough to enable the operator to stand straight. A roll should be placed under the neck so as to raise the shoulders and incline the head backward. I prefer this to the Rose position. When the patient is anesthetized, the tongue should be seized with the tongue forceps (Fig. 508), lifted forward so as to render respiration easy and more satisfactorily expose the entire palate. The oral speculum (Fig. 500) should then be introduced when the field of operation is brought clearly into view.

Instruments.—After procuring all the instruments known in this country and in Europe, in the form of mouth gags with which to open the mouth and expose the parts during operation, I devised the oral speculum illustrated (Fig. 510). It not only depresses the tongue, but holds the mouth open and, by reflection of light, illuminates it, giving the surgeon a full view of the field of operation. I have found the long, curved, clamp forceps (Fig. 510), modified by myself, to be the best for carrying sponges and cleaning the throat. The clamp of the forceps holds the sponges firmly and its curve enables the operator to carry it into the pharynx and thus cleanse it more thoroughly. The assistants and the operator himself can pick up the sponges more quickly and satisfactorily with the forceps, use them, throw them away and pick up others than they could by dropping one sponge-laden instrument and picking up another. Sponges of gauze should be prepared in three sizes, the largest suited to sponge the throat, the medium size to keep the surfaces of the palate clean and the smallest ones to dry the borders of the fissure while the coaptation sutures are being introduced and tied. The most convenient place for the instruments during the operation is on a bracket table suspended directly over the patient.

Sutures.—The materials employed in my own operations include lead, sutures of silver wire and hair, either from horses or cattle.[1] These sutures do not absorb the secretions, consequently they are preferable to silk or any other fabric capable of absorbing moisture. The field of operation, by reason of the fact that we have not introduced anything that can absorb or retain secretions, is kept as nearly aseptically clean as is possible in the oral cavity.

[1] I have spoken of cattle hair being stronger than horse-hair and this, I think, will be verified by anyone who will take pains to experiment with them.

In my earlier experience, I am satisfied that infection of the parts in certain cases resulted from the use of silk and linen sutures. With frequent irrigation and non-absorbing sutures, I now obtain more satisfactory results than by the use of any other material. Infection following operations is extremely rare.

WHEN TO OPERATE

In the literature on Cleft Palate, with special reference to the most favorable time in life to perform these operations, the teachings and practices of surgeons have been, with few exceptions, opposed to operating in early infancy. As to the most desirable age for operation, Professor Kirmisson[1] states: "Before the employment of chloroform, the operation was necessarily delayed until the child became old enough to understand the operator's instructions. Thus Roux put the age at sixteen years; Augenback and Trelat operated at seven years. At the French Surgical Congress in 1889, Ermine reported his results of early operations. He operated upon ten children under two years of age with six good results, two deaths and two failures. Twenty children between the ages of two and six months underwent operations with seventeen good results, two deaths and one failure; lastly, eleven operations between the ages of seven and ten years, showing ten good results with one failure." These results, says Kirmisson, speak against operations in early childhood.

He further says: "J. Wolff of Berlin recommends early interference and unhesitatingly operates on children of from one to two years. I have not had an opportunity to see Wolff operate. I must confess, however, that, notwithstanding his excellent operative technic and the employment of his tampon, operating at this early age strikes me as difficult and dangerous. The field for operating is too small, the tissues thin and the sutures, therefore, easily cut through." This statement of Professor Kirmisson is an argument in favor of postponing the operation on the lip so as to enable us to get the benefit of extra room which the labial opening affords us. Further he says: "There exists the danger of severe hemorrhage, and, lastly, it is almost impossible to follow the operation successfully with antiseptic asepsis. Therefore, I strongly recommend operating between the fifth and sixth years."

Garretson on Early Operation.—Professor Garretson speaks[2] of the desirability of operating on young children. The reasons which he gives favoring an early operation are stated in these words: "When a child is thus, unfortunately, born and the attention of the surgeon is called to the case, it seems to me but a single question presents itself for his consideration, namely, how the deformity may be corrected. Suffered to exist, *every day will in-*

[1] Article on Congenital Cleft Palate in Karl Deutschlander's work on Congenital Deformities.

[2] Text-book, Edition 1869.

crease the difficulty of the cure,[1] that is, so far as the most formidable part of the operation is involved, while if attempted at once, the prospect of complete success is very great. Young bone, or bone at birth, as is well known, is almost if not quite made up of animal material, while in the osseous structure of the adult, there is an excess in the limey, or unyielding material, of from 75 to, perhaps, quite 85 per cent. Let me refer to the old experiment of the maceration of bone in dilute muriatic acid to illustrate more familiarly this yielding constituent of bone. We know that if we subject a bone to the action of this acid for one or two weeks, we may tie a rib like a whip-cord. I have removed a rib from a living young cat and played with it in this same whip-cord manner. I have perceptibly bent the femur of a young child, but no one, I imagine, ever performed such a manipulation on the femur of an adult. You may take an inferior maxillary bone even in the child of fifteen years, where the projection of the chin is so great as to produce deformity, and with a properly constructed vertical-mental elastic sling, you may, in a period varying from three weeks to as many years, so change the angle of the bone as to do away entirely with the deformity. You may take the projecting myrtiform border and, through the instrumentality of the occipital-alveolar plane, you may, in quite a short period, compel it to a natural articulation. On this known yielding character of young bone, therefore, operations for the correction of congenital fissures of the hard palate may be founded."

Again later in his work, we find Garretson making the following statement: "These suggestions for the cure of cleft in the hard palate were, I thought, original with myself, though it is of slight consequence who invents an operation so that it is good, but in the periscopic department of the *Dental Cosmos* I find the following extract, made by Dr. Ziegler, from the *Australian Medical Record* and *Dublin Medical Press*, which shows that the operation was conceived by another before it presented itself to my mind. The extract is a short one, and so *apropos* to the matter that I shall take the liberty to quote it entire.

" '**Pressure in the Treatment of Cleft Palate.**—I am not aware,' says the author, 'that the subject of using pressure in treating fissure of the palate has been before suggested. I am inclined to think that it has not, for when the plan first presented itself to my mind in 1851, I carefully examined French, German and American works to see whether it had. I was first led to try it on the dead body of a child which had died three weeks after birth. The fissure was longitudinal and large enough to admit the extremity of the little finger. Fissure of the lip also existed. By means of a pair of clamps, the sides of the fissure were brought readily into contact, without any fracture or displacement of the bones. The only fault was that the gums of the upper jaw were within those of the lower, but Nature would modify this as the living

[1] Italics mine.

child grew up; the use of pressure on the lower jaw would remove a great deal of this deformity. Of course, the amount of deformity would depend on the size of the fissure in the palate. Several times I repeated the experiment on young dogs, removing a piece of palate bone by means of Hey's saw and then applying the pressure. The animals did well.

The operation should be performed as early as possible after birth when the bones are in their softest condition. The following is the plan which I would suggest: The edges of the fissure having been pared, the superior maxillary bone should be embraced by a horseshoe-shaped clamp with a shelf on its lower border to receive the gums and prevent its slipping. It should be padded with india-rubber or some other material to prevent the germs of the teeth from being injured. The clamp should work on a joint and possess arms. It may be said to resemble a large pair of pincers with horseshoe-shaped blades. A screw may be attached at the extremities of the handle for the purpose of bringing the blades in contact, or the hands may be used. The former would be preferable, I think, as the force could be applied gradually and not be likely to be carried too far. It may also be employed in grown-up children when the bones are so widely separated as to render it difficult to get soft parts enough to close the opening, but in a gradual manner and at intervals more or less prolonged, according to the amount of pain it excites. If it were used suddenly, it might produce inflammation and, subsequently, abscess, which would prove troublesome to treat. From the foregoing, I hope, it will be understood that *the younger the child the safer the operation is likely to prove*, and that even in grown-up children it may be adopted with precautions with decided benefit.[1]

The pads and the ledge to rest the teeth upon should be made to slide in the sides of the clamp; the former, that the pressure may be directed upon any part of the bone; the latter, that the edges of the teeth may rest on it without the pressure being directed either too high or too low, but at the point where the palate bone joins the superior maxillary.'"

Author's Views on Early Operation.—In 1885, having become familiar with the methods employed generally by surgeons throughout the world, and having studied the deformity from every point of view, I concluded that the time best suited to close a cleft palate was as early after birth as it was possible to operate. The basis of my belief was that a cleft might be closed by a little pressure immediately after birth, whereas, six months later, the bones would be so ossified that the moving of them together would be attended with difficulty and, besides, the results of the work would not be as satisfactory. A cleft palate is a *fissure, a separation of well-developed parts, not the result of arrested development nor failure of the normal quantity of tissue to enter into its structure.* It is practically a wound. I hold, therefore, that *it should be closed in early infancy when it can be accomplished most easily.* Our text-books and professors of surgery, with few exceptions, teach that congenital

[1] Italics mine.

harelip should be operated upon in early infancy and that no attempt should be made to close a cleft palate until the child is several years old. The practice and teachings of surgeons of highest repute have led medical men, quite generally, to advise those seeking information as to the most desirable time to operate for harelip and cleft palate to have the lip operation performed at once and to postpone the palate operation until the child is from three to ten years old. I have endeavored not only to overcome the objections raised to early operations, but also to avoid difficulties with which the older surgeons contended. *After many years of study and clinical experience, I am satisfied that the most desirable time for operating upon cleft palate is within three months after birth. At that time we are able to secure more satisfactory results than in later life and we also avoid the objections usually raised by surgical writers.*

In the light of surgical advancement and the development of modern methods of procedure, *no cleft palate patient should be permitted to attain an age when speech is attempted without having an operation performed and the defect removed.* Students must no longer be taught methods which should be obsolete in this field of surgery; they must not permit the deformity to remain without attention; they must qualify themselves in modern methods in this special surgical work as they do in other departments of surgery. Having, then, in mind the anatomical defects of the palate, they should seek to overcome them, *bring the abnormal anatomical parts into normality and thus establish more perfect functional results.*

I am but too well aware that the methods that I have devised are not generally practised and that they have been criticised by those who do not fully comprehend them. It is gratifying, however, to realize that many of our most distinguished surgeons, who formerly questioned my procedure, are now most enthusiastic advocates of it and are operating with satisfactory results. The question of early operations has long since passed the experimental stage. I will confess that my first cases were undertaken with a great deal of hesitancy. I knew that I was transgressing all the long accepted rules of surgical procedure, but it seemed to me so reasonable that the patient should be able to undergo the necessary trial that I ventured. We know that the struggle of birth is often more severe than this. There are sometimes displacements and replacements of the cranial bones during this critical natural process more radical than that of bringing into apposition the separate bones of the maxillæ. It has been the observation of every obstetrician that injuries which the child sustains during parturition do little immediate or ultimate harm.

A surgeon never hesitates as to his duty in the presence of a wound; his first impulse is to close it. Should a family with a young infant meet with an automobile accident, the mother and the child being thrown out of the car with the result to the child of a complete cleft of the lip and palate, the bones being forced apart, would the surgeon suggest postponing operative procedure

for a few weeks, or a few months, or a few years? *Certainly not.* He would immediately employ means to bring the separated bones and lip into normal relations that union might take place. The same reason exists why a union of a congenital cleft of the palate should not be delayed. So a cleft palate, not unlike a wound, calls for measures which have as their aim the closing of this wound, this fissure. A surgeon does not postpone the closing of a wound; he should not postpone the closing of a cleft palate.

The literature on the subject of cleft palate clearly shows that surgeons do not even contemplate or propose treating the cleft of the bone. Their aim seems to be to cover up the great deformity by closing the lip and to permit the bones to remain permanently separated. If medical men everywhere real-

FIG. 410.

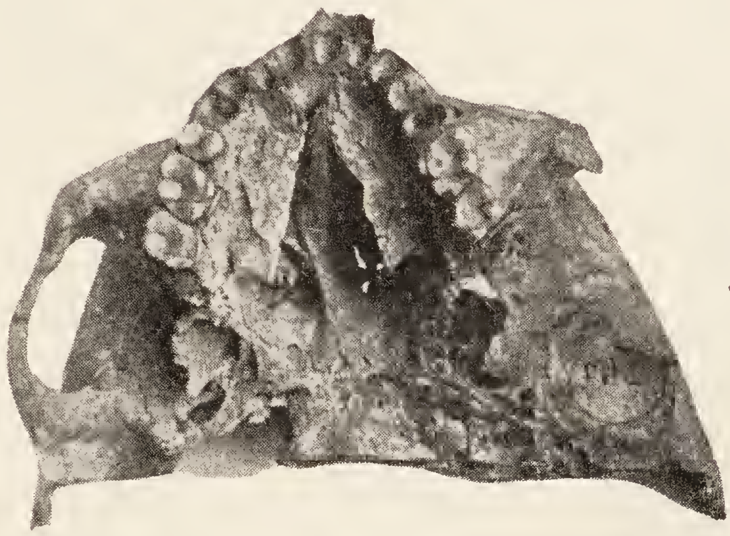


FIG. 411.

FIG. 410.—Closure of the lip has brought the alveolar processes in contact by traction of the m. orbicularis oris. While the edges are in contact they are not united. They cannot unite because of the intervening layers of mucous membrane. The long portion of the bone protrudes far beyond the short one as it usually does and a deformity still exists. Had the edges of the cleft been freshened and approximated in early infancy, a normal arch would have been produced.

FIG. 411.—Cleft palate in an adult who had lip operated. Anterior part of the cleft was closed by traction of the mm. orbicularis oris. The deformity remains in the posterior part which is widely separated. By approximation of the bones, the cleft could have been closed, resulting in a palate of normal breadth.

ized that palatal surgery, like other fields of surgery, has made great progress during the last quarter of a century, and if all physicians would inform their patients as to modern methods in the treatment of cleft palate, every community would not include adults with this deformity who have been permitted to become permanent sufferers for life by reason of their failure to receive, in early infancy, the surgical treatment they required.

In monographs written many years ago, I made the statement that, in some instances, palates upon which operations are delayed failed to develop for want of use of their various parts. *I have no doubt that an adult, growing up with a cleft palate, has not the full complement of tissue that forms a perfect palate since this tissue has failed to develop in proportion to other parts, as it has not been subjected to the uses for which it was intended.* Hence, the importance

of closing the cleft and putting the palate in use in early infancy. We observe in certain cases that, following closure of harelip, the alveolar borders of the anterior extremity of the cleft, by reason of the traction of Mm. orbicularis oris, gradually approach each other. In some instances they come in

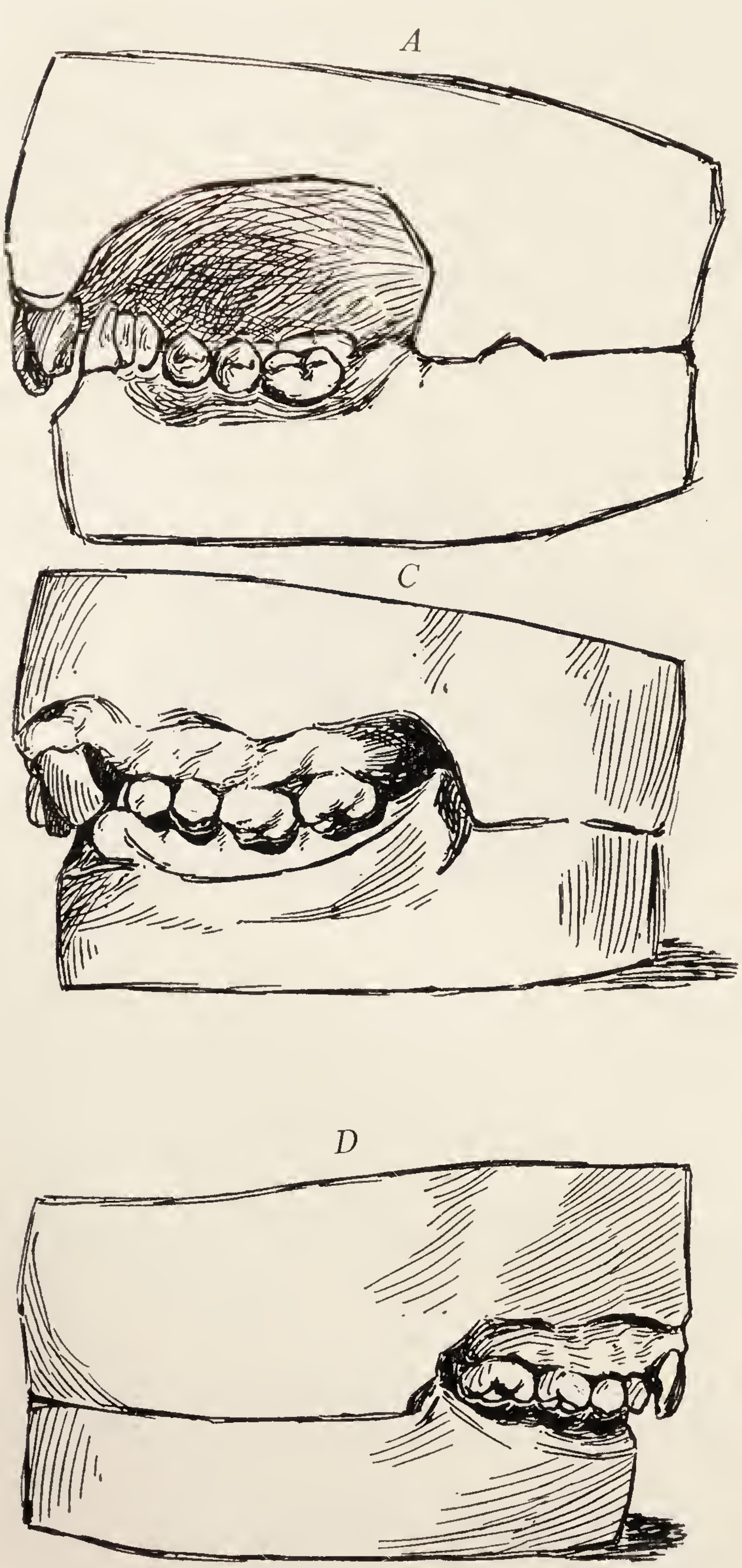


Fig. 412.—*A* and *B*, sectional drawings of the mouth of a boy thirteen years of age, with cleft palate, showing the overbite. *C*, *D*, and *E*, different views of the same mouth, showing the overbite of all the superior teeth when the models are articulated.

contact (Figs. 410 and 411). Furthermore, by traction of the Mm. buccinator, the posterior alveolar borders are drawn inward and the palatal plates carried upward, thus narrowing the arch and elevating to the extreme the divided palatal plates, but more frequently the anterior alveolar borders of the maxillary bones are approximated, which does not correct the

palatal defect nor reduce the breadth of the fissure at its distal border (Fig. 412,*A*). Such a condition is a rare exception to the statement made that the upper jaw is just as much broader than it should be as the distance between the borders of the fissure.

In December, 1913, I sent the following personal communication to twenty-eight physicians and physiologists in the United States:

"My dear Doctor:

In operating on infants for the treatment of congenital cleft palate, my observations have led me to believe that the shock is less severe following an operation under three months of age than it would be between twelve and eighteen months.

In an article which I have written, I make this statement: 'My experience in operations performed for the closure of cleft palate at from ten days to three months of age has more and more confirmed my opinion and justified the practice. I believe in operating at as early an age as practicable after birth, usually within the first three months. My reasons are as follows...... The surgical shock is less because the nervous system of a young child is not well developed and it is not, therefore, capable of receiving the same impressions that it would later in life, for young children usually react better. Moreover, all mental apprehension is eliminated and we all know that alarm and dread are among the most powerful factors in producing shock.' "

The replies received were extremely interesting and, on the whole, support my contention. As will be noted, the list contains the names of those who are surgeons with wide practical experience and those who devote their time to physiology. From the physiologist's stand-point, Dr. A. J. Carlson of the University of Chicago states: "I agree with your position as regards *early* operation for cleft palate. The new-born and the very young mammal is much less affected by direct injury to the central nervous system than is the older mammal; that is to say, there is much less so-called *spinal shock* in the young. There are also good reasons for the view that the new-born is much less subject to the *surgical shock that results from trauma of afferent nerves*, owing to lower excitability of the nervous tissues. I should think that, other things being equal, the earlier the cleft is united, the less extensive and conspicuous the scar."

Dr. Winfield S. Hall writes: "We find that new-born and very young animals bear experimental operations with less shock than do older animals, also with a smaller percentage of mortality and noticeably better recovery. This experience is confirmed by my associate, Dr. R. J. Hoskins, who had the same experience with guinea-pigs in Harvard University. We, therefore, concur in the position taken in your article from which you quote."

Dr. J. A. Eyster says: "I would say that, on the theory of shock as due to long-continued inflow of abnormal sensory impulses into the central nervous system, your position in reference to operations on infants has support in experimental observation."

Another, who wishes his name withheld at the present time, pending further work, writes: "It seems that your reasoning is good and that, with proper care to conserve bodily heat, there is no reason why you should not get good results. There is another matter on which I have only a few incidental observations and that is, the rather remarkable viability of the organs of new-born mammals. I have seen respiratory movements started in a kitten after procedures which certainly long before would have definitely ended the life of a full-grown cat, and further, I have seen the heart beat long after the death of the organism. The same observation has been made on the heart of the human infant. It looks as if the new-born were provisioned for survival and that they are, in fact, much more resistant than older individuals."

It would seem, from the above remarks by physiologists, that there is some ground, from a theoretical standpoint at least, for the views I hold. In all the replies I received, no radically opposed statement has been put forth. Some have disagreed with the exact wording of the statement I made, as, for instance, Dr. S. J. Meltzer of the Rockefeller Institute for Medical Research, who writes: "Theoretically, I would say that your view on the subject coincides to a degree with certain views I entertain personally and they are as follows: I have stated elsewhere[1] that the fundamental basis of shock is the development of *inhibition*. Now we know that the phenomena of inhibition develop very gradually in infants; they seem to be present in the first few days of the new-born. The opposite of inhibition is hyperkynesis. We know that convulsions and epileptic fits occur more often in the very young. It is, therefore, perhaps, not wholly correct to state that 'the nervous system of a young child is not well developed,' etc., as you say, but that the inhibitory mechanisms are not well developed. Of course, those who believe that shock is due to an exhaustion of the vasomotor center (Crile) or to a loss of carbon dioxide (Henderson) will have trouble to adapt their theories to your observations. But, never mind, theories are like soft clay." The main idea as expressed by me is concurred in by Dr. Meltzer.

The following are some quotations from those who have had practical experience from a surgical point of view.

Dr. G. W. Crile writes: "I am sure you are right. The neuron arcs are not completed at that time and, in a way, the operation is comparable to one under anoci-association."

Dr. T. H. Weisenburg says: ". . . . certainly the surgical shock is less in a child under three months of age than in one older. Not only that, but it strikes me there is another and equally important reason: the longer a defect is allowed to remain, the greater it will become, and it should be easier to correct a developmental fault at a time near birth than a year or two later."

Dr. H. N. Moyer also concurs with the last statement.

The following is from Dr. Charles L. Dana: "I would say that your

[1] Arch. for Internal Medicine, Vol. 1.

experience is in conformity with what we know of the physiology of the child. The central nervous system is not completely medullated during the period which you mention."

Dr. Howard A. Kelly writes: "It seems to me that the best judgment of the several men in the world, including your own, is all in favor of the early operation. It is better for the child in every way and there is less shock attending the operation."

Dr. James W. Putman says: "I believe you are right in your contention that it is wise to operate at as early an age as possible after birth—within the first three months—not only in cases of cleft palate, but in other conditions as well."

On the other hand, Dr. B. Sachs writes: "So far as my surgical experience goes, the younger the child the less tolerance it shows toward any surgical operation. You may eliminate the mental apprehension part altogether. It is merely a question of how much loss of blood and how much of the narcosis a young child can stand. Those are, to my mind, the chief elements in the question as applied to very young children." This physician is the only one who does not agree with me.

From all the above, I believe that I can safely state that there is no valid reason why one should wait any longer than is *absolutely* necessary to operate on children for cleft palate.

Surgical Anatomy of the Soft Palate.—The surgical anatomy of the region is to be fully understood. So much of success depends upon a thorough knowledge of the muscular relation to the cleft that such acquaintance gives success where otherwise failure would be sure to result.[1] This anatomy we may look at before taking up the steps of the operation.

To get a correct idea of the soft palate we commence to study it by first carefully examining the parts on the living subject. When we look into a mouth, we see an arch stretching from every portion of the alveolar ridge inward and backward towards the pharynx, terminating in a tongue or uvula, pendant in a vertical direction from its center. One-half of this arch is seen to be fixed, the other, the posterior half, in almost constant motion. If now the finger be called into the service, the fixed part is found to correspond with the boundaries of the palatine faces of the maxillary and palate bones, that is, for a certain extent the parts are felt to be solid as if the finger passed over an arch of bone which might be covered alone by mucous membrane, and this is, in fact, about the case. The finger traverses the anterior bony border of the mouth or the hard palate. As now the finger is passed backward, it falls over a hard ridge upon the parts that are soft and yielding; the hard ridge is the posterior face of the palate bone and terminates in the hard palate. The part upon which the finger has fallen is the veil, or soft palate, the part observed to be movable. This is the region in which occurs the rent or cleft, for the cure of which is demanded the operation about to be considered.

[1] Garretson.

The mobility of this part, which pertains to its function, depends, as will be anticipated, on an associated muscular structure. To study this structure properly, which it is all-important to understand and appreciate practically, the student is to take up a scalpel and pass to the cadaver. It is, perhaps, only by dissecting that a really satisfactory idea of these muscles is to be secured, that is, as pertains to that kind of knowledge which gives confidence when one comes to perform operations upon the parts.

The external coat, or covering, which is seen in every mouth, living or dead, is the mucous membrane, simply the continuation of that which covers the hard palate, but while, in the case of this part, the underlying structure of this hard palate is found osseous, in the soft palate the deep tissue is made up exclusively of muscular substance, at least as far as surgical anatomy is concerned or as it serves the present purpose to study it.

Commencing with the mesial line, one can dissect out the attachment of five muscles, each of which is, of course, duplicated on the opposite side and each of which has such relations to a mesial line that, in case of cleft or split, it serves more or less to draw the parts postero-laterally.

These muscles, mentioned in the order of their significance to such lateral displacement and, consequently, in their relation to the operation of staphylorraphy, are the tensor palati, palato-glossus, levator palati, palato-pharyngeus and azygos uvulæ. Of all these structures the tensor palati plays the most important part and it is, therefore, entitled to the first consideration. This muscle arises from the scaphoid fossa, at the root of the internal pterygoid plate, from the anterior surface of the Eustachian tube and from the spinus process of the sphenoid bone. If the student carry his finger in his own mouth back to the wisdom-tooth of the superior jaw and let it drop over and back of this organ, it will fall on the tuberosity of the maxillary bone; carry it about half an inch farther back and it will come to a second prominence; this is the hamular process of the pterygoid plate of the sphenoid bone. The tensor palati muscle descends from the origin of which we have just informed ourselves, and, meeting this hamular process, it winds, as a tendon, around it and then by a fan-like expansion spreads itself into the substance of the soft palate (Plate III). Its action is evident: it expands the palate laterally (*and dilates the pharyngeal orifice of the Eustachian tube*).[1]

Removal of Strain.—To perform successfully the operation for cleft palate, it is, perhaps, desirable in every case that the strain upon this muscle be taken off. A moment's reflection will show that the action of the muscle in case of a cleft would, when the parts are brought together, be much increased over its natural capabilities, not only because it would be put considerably on the stretch, but also because such stretch would, more than likely, excite to spasmodic contraction. (*The practice of surgeons, as has been previously stated, has been to divide the fibers of the muscles with a view to relieving the*

[1] Author's own words.

tension or taking off the strain.[1] *The author's introduction of lead plates, fixed with wire sutures, not only overcomes the strain, but greatly diminishes the motion of the palate and acts like a splint holding the tissues in quiet contact until union of the approximated edges takes place. It is, therefore, unnecessary to divide the muscle.*[2])

Tensor Palati Muscle.—It is to be remarked that the muscle is to be found winding, as a tendon, around the hamular process. It winds from the back outwardly, inwardly and forward.

Palato-glossus Muscle.—The next most important muscle is the palato-glossus. This is simply the anterior half-arch, the constrictor isthmii faucium. It arises, as will be seen, from the soft palate on either side of the uvula, passing outward, is inserted into the sides of the tongue, blending with the stylo-glossus muscle.

Palato-pharyngeus Muscle.—The palato-pharyngeus arises from the soft palate by an expanded fasciculus and, passing outward, goes to be inserted into the posterior border of the thyroid cartilage. The two muscles constitute the posterior half arches.

Levator Palati Muscle.—The levator palati muscle arises from the petrous portion of the temporal bone, passes into the interior of the pharynx and then descends obliquely downward and inward, spreading its fibers out over the posterior surfaces of the soft palate as far as the raphé.

Azygos Uvulæ Muscle.—The action of the fifth and last muscle, the azygos uvulæ, is, perhaps, not necessary to consider, its influence for separation of the wound being very trifling.

The other anatomical elements of the soft palate are glandular structures, vessels, nerves, etc., all associated, more or less intimately, by connective tissue, but these need not be particularly referred to as one could not well resect out the muscles without necessarily familiarizing himself with them. Thus, then, we understand the surgical anatomy proper of the parts, the anatomy as it has relation to the cleft palate."

CLEFT PALATE OPERATIONS

The Operative Aim.—The object to be attained in the treatment of congenital cleft palate is to establish normality. The success of the surgeon will be measured by this standard. The development of the nose, pharynx and mouth, in fact, the entire development and well-being of the patient is dependent upon the surgeon's ability to move into contact and unite these separated parts. It is to the credit of the dental profession that the first operation for the closure of cleft palate was proposed in 1764 by a dentist. Inseparably associated with staphylorrhaphy is the name of the dentist La Monier, a Frenchman, who first believed that this most conspicuous and

[1] Lead plates were first designed and used by the author in 1883.
[2] Author's own words.

distressing deformity was amenable to successful surgical treatment. Fifty-five years after La Monier proposed to close the palate by surgical methods, Roux, of Paris, in 1819, was the first to lay down and publish rules to be observed in the performance of these operations. In 1820 Warren, of Boston, without a knowledge of Roux's work, brought before the profession a similar, but somewhat modified operation, which was favorably received and adopted by many leading surgeons throughout the world. During a period of twenty-five years this operation was performed by such distinguished surgeons as Graefe, Sebileau, Dieffenbach, Liston, Pollock and Sir William Fergusson of Europe, the younger Warren, Wells, Maccauer, Stevens, Gibson, Hossack, Mutter, Pancoast and Agnew of America.

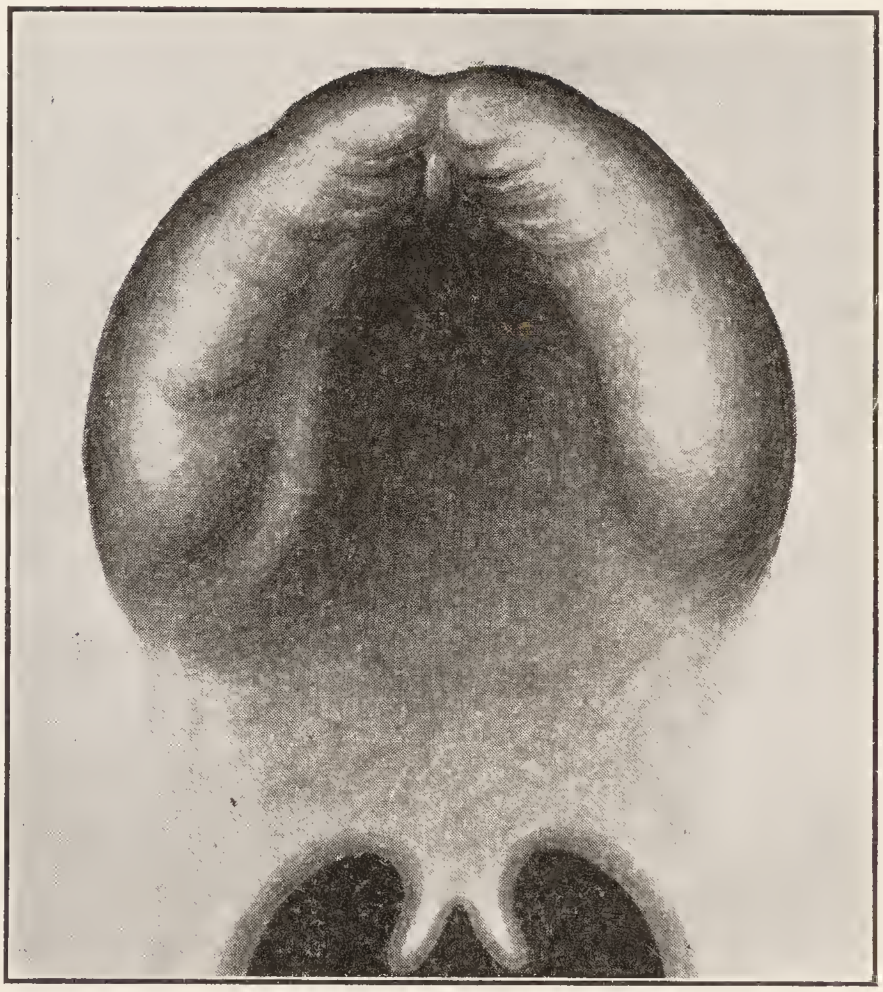


FIG. 413.—Form 1. Cleft of the uvula (partial).

Many names are given to the operation upon the palate.

Staphylorrhaphy, cionorrhaphy, palatorraphy are the names given to the operation in which the edges of the cleft palate are sutured.

Staphyloplasty is the name given to that operation in which a defective uvula is restored or in which the gap in a cleft palate is filled by a flap taken from the wall of the pharynx.

Uranoplasty is the name given to any plastic operation for the cure of a cleft palate involving the bones.

La Monier, a dentist of Paris, was the first to perform staphylorrhaphy. This was a great many years ago. He had as his object the bringing together of the separated portions of the cleft of the soft palate and retaining them in

place until they were united by Nature. He divided the operation into four stages:

1. Paring the edges of the cleft.
2. Introduction of sutures.
3. Bringing the freshened edges together and fixing them.
4. Relieving the tension on the sutures.

Forms of Cleft Palate.—To describe Congenital Cleft Palate operations clearly and accurately in all the forms we present the subject under fifteen heads:

Form 1. Cleft of the Uvula (Partial) (Fig. 413).

Form 2. Cleft of the Uvula, extending forward to the fibers of the levator palati and the reflected portions of the tensor palati muscles (Fig. 414).

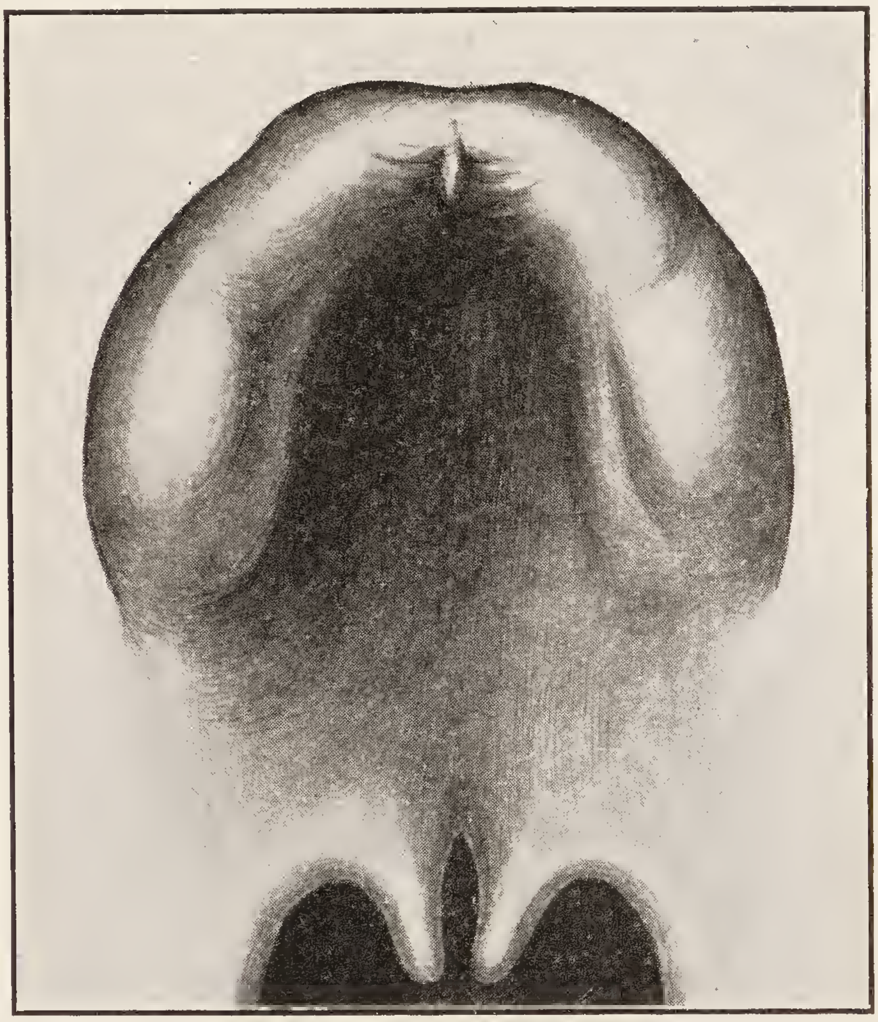


FIG. 414.—Form 2. Cleft of the uvula, extending forward into the fibers of the levator palati and the reflected portions of the tensor palati muscles.

Form 3. Cleft extending through the uvula and forward to the posterior border of the horizontal plates of the palate bones (Fig. 415).

Form 4. Cleft extending through the entire soft palate, including partial or complete cleft of the horizontal plates of the palate bones (Fig. 416).

Form 5. Cleft of the entire soft palate, extending through the horizontal plates of the palate bones and into the palatal processes of the maxillary bones (Fig. 417).

Form 6. Cleft of the entire soft palate, including the hard palate as far forward as the line of union between the palatal plates of the maxillary bones and the premaxillary bones (Fig. 418).

FIG. 415.—Form 3. Cleft extending through the entire soft palate, including partial or complete cleft of the horizontal plates of the palate bones.

FIG. 416.—Form 4. Cleft extending through the uvula and extending forward to the posterior border of the horizontal plates of the palate bones.

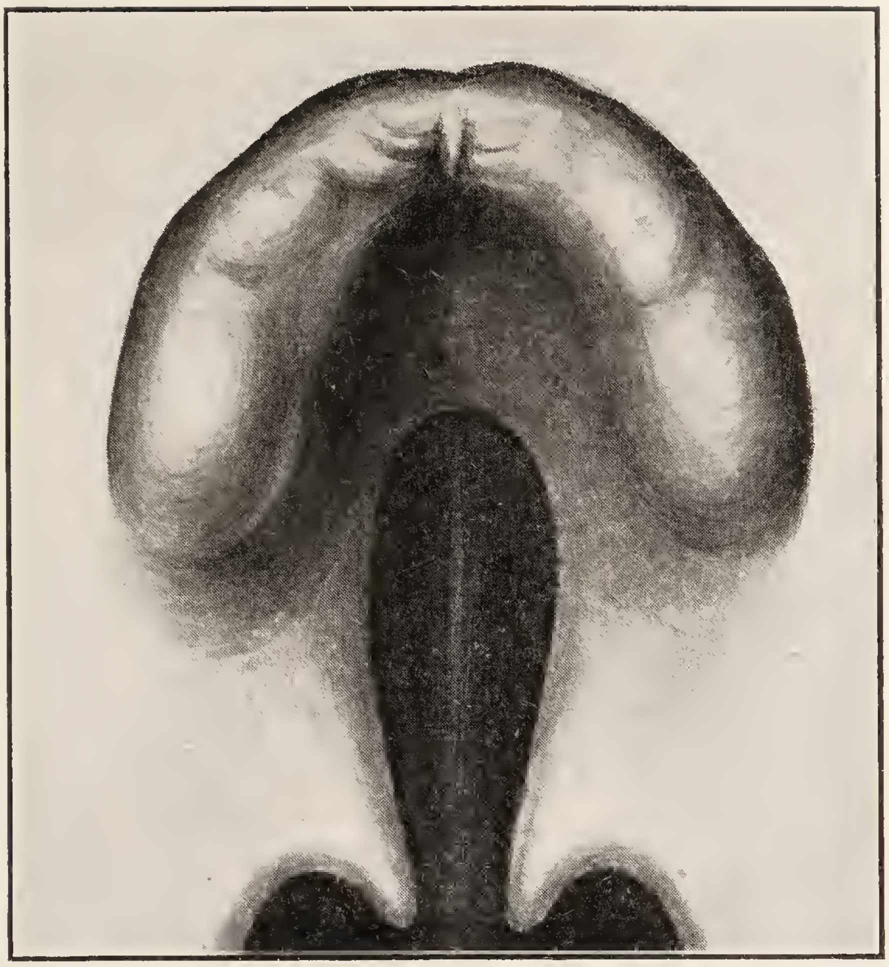


FIG. 417.—Form 5. Cleft of the entire soft palate, extending through the horizontal plates of the palate bones and into the palatal processes of the maxillary bones.

FIG. 418.—Form 6. Cleft of the entire soft palate, including the hard palate as far forward as the line of union between the palatal plates of the maxillary bones and the premaxillary bones.

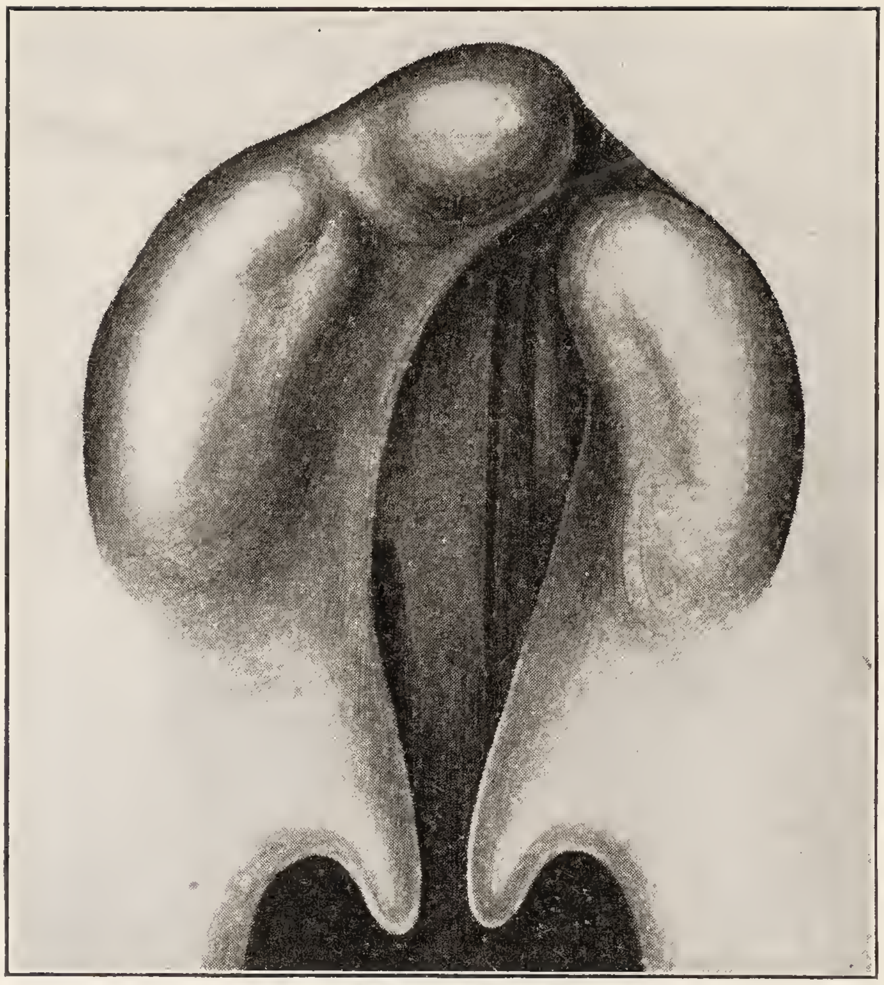


FIG. 419.—Form 7. Complete single cleft of the entire soft and hard palates. The maxillary bone is separated from the premaxillary bone. Almost invariably this deformity is complicated with harelip. The harelip may be partial or complete. The vomer, as a rule, is attached to the opposite side.

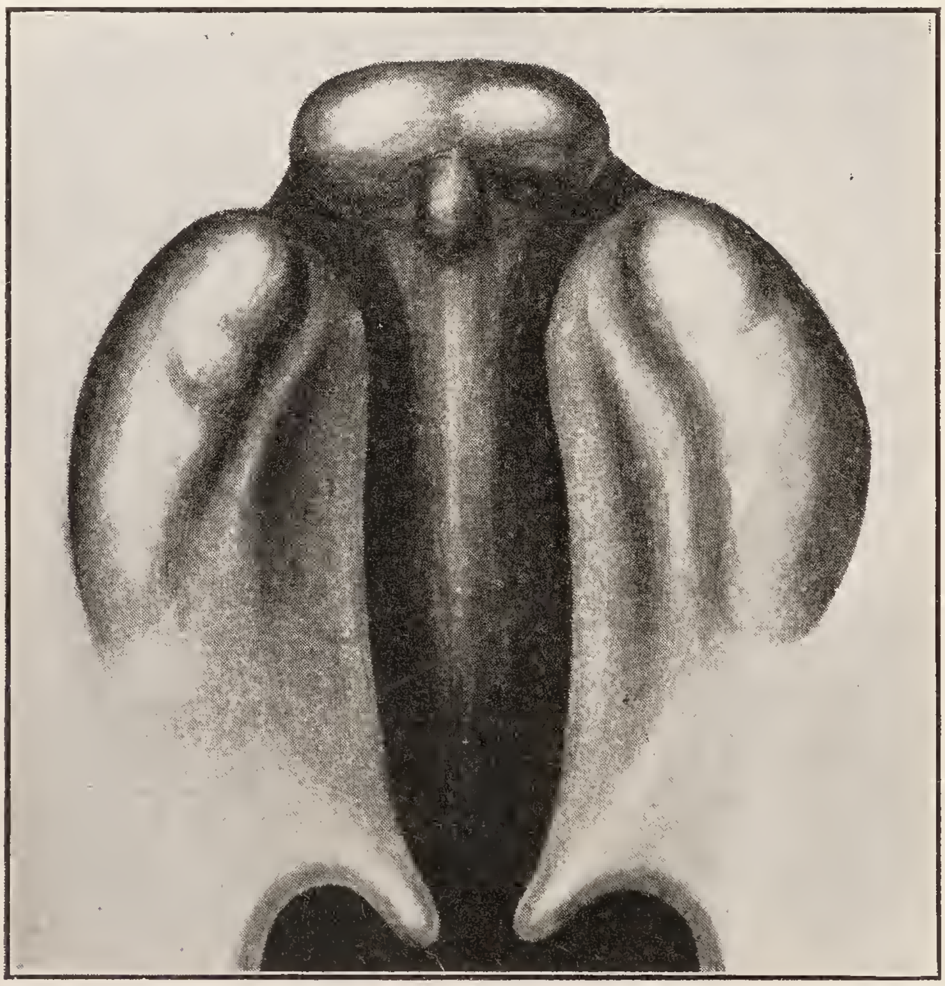


FIG. 420.—Form 8. Tripartite cleft, extending through the soft and hard palates, separating the premaxillary bones from the maxillary bones often complicated with double harelip.

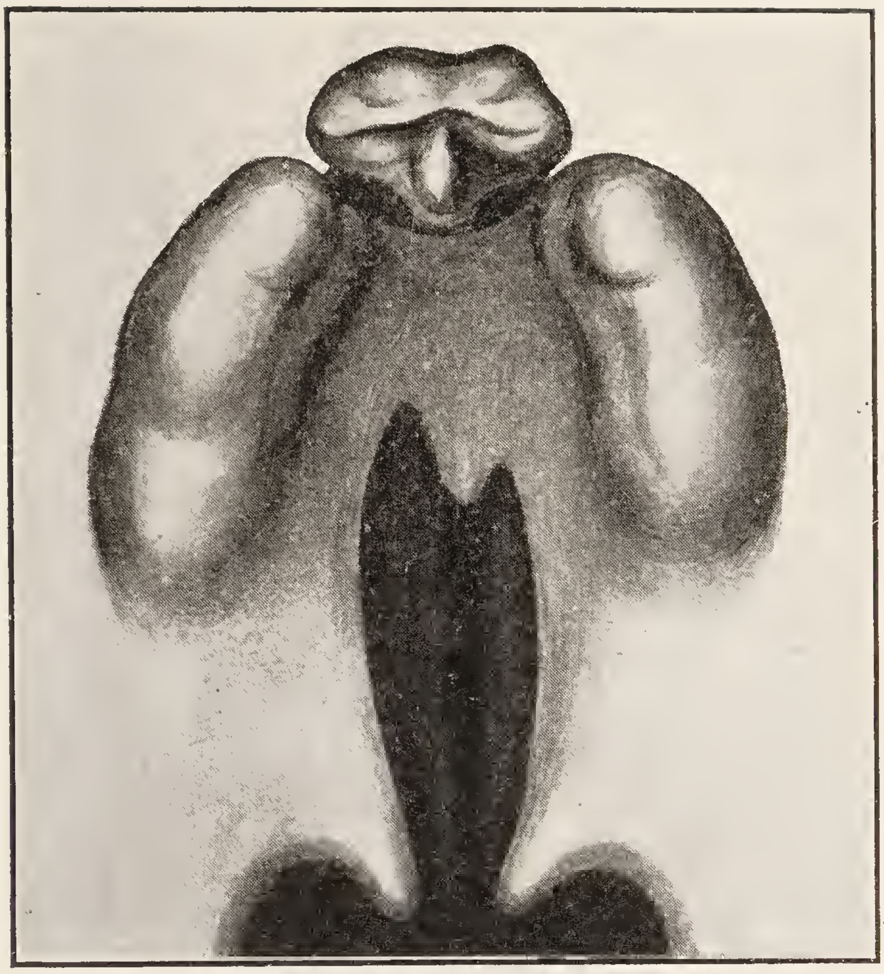


FIG. 421.—Form 9. Cleft of the entire soft palate which extends irregularly half way through the hard palate. The anterior portion of the hard palate is united as far forward as the premaxillary bones. The premaxillary bones are entirely separated from the maxillary bones. This rare condition is usually complicated with double harelip.

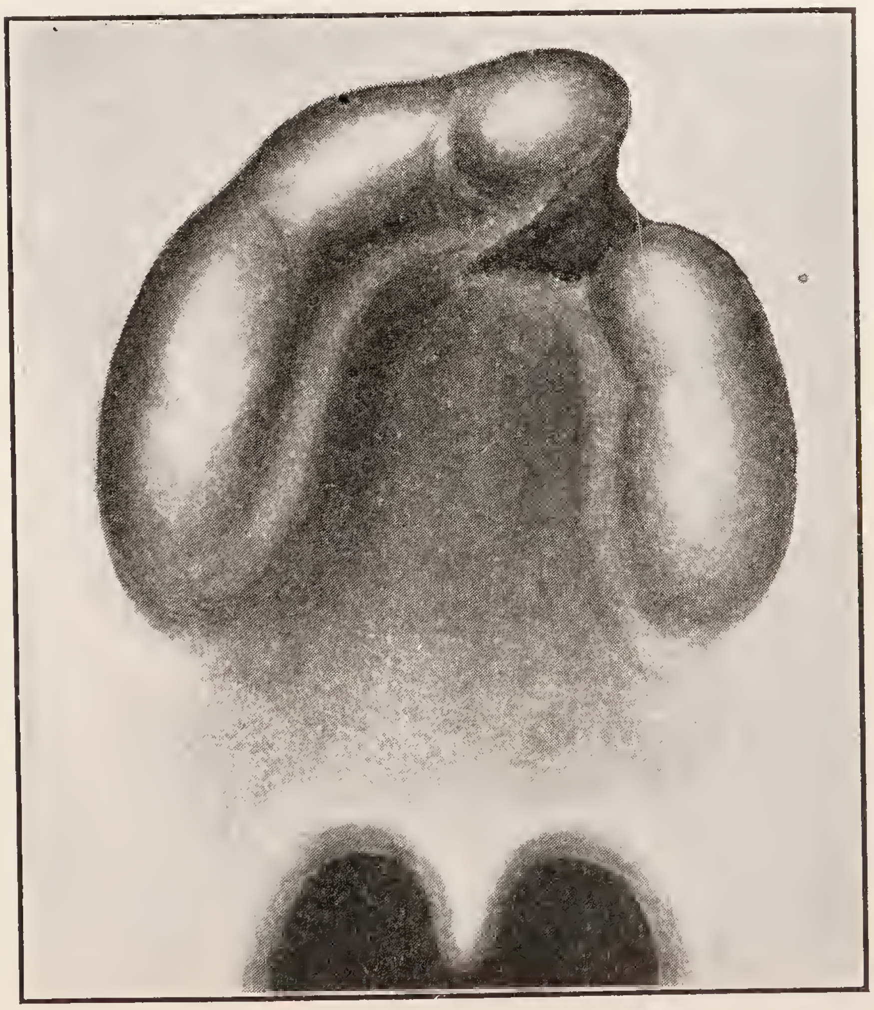


FIG. 422.—Form 10. Cleft only between the maxillary and premaxillary bones. The cleft may be accompanied by harelip, single or double, and protruding premaxillary bones, which is diverted to the opposite side. It may be without lip complications.

Form 7. Complete single cleft of the entire soft and hard palates. The maxillary bone is separated from the premaxillary bone. Almost invariably this deformity is complicated with harelip. The harelip may be partial or complete. The vomer, as a rule, is attached to the opposite side (Fig. 419).

Form 8. Tripartite cleft, extending through the soft and hard palates, separating the premaxillary bones from the maxillary bones, often complicated with double harelip (Fig. 420).

Form 9. *Cleft of the entire soft palate which extends irregularly half way through the hard palate. The anterior portion of the hard palate is united as far forward as the premaxillary bones. The premaxillary bones are entirely separated from the maxillary bones. This rare condition is usually complicated with double harelip* (Fig. 421).

Fig. 423.—Form 11. Cleft completely separating both premaxillary bones from the maxillary bones.

Form 10. Cleft only between the maxillary and premaxillary bones (Fig. 422). The cleft may be accompanied by harelip, single or double, and protruding premaxillary bone, which is diverted to the opposite side. It may be without lip complications.

Form 11. Cleft completely separating both premaxillary bones from the maxillary bones (Fig. 423).

Form 12. *Cleft only of the anterior one-third or one-half of the hard palate with protruding premaxillary bones. The latter are entirely separated*

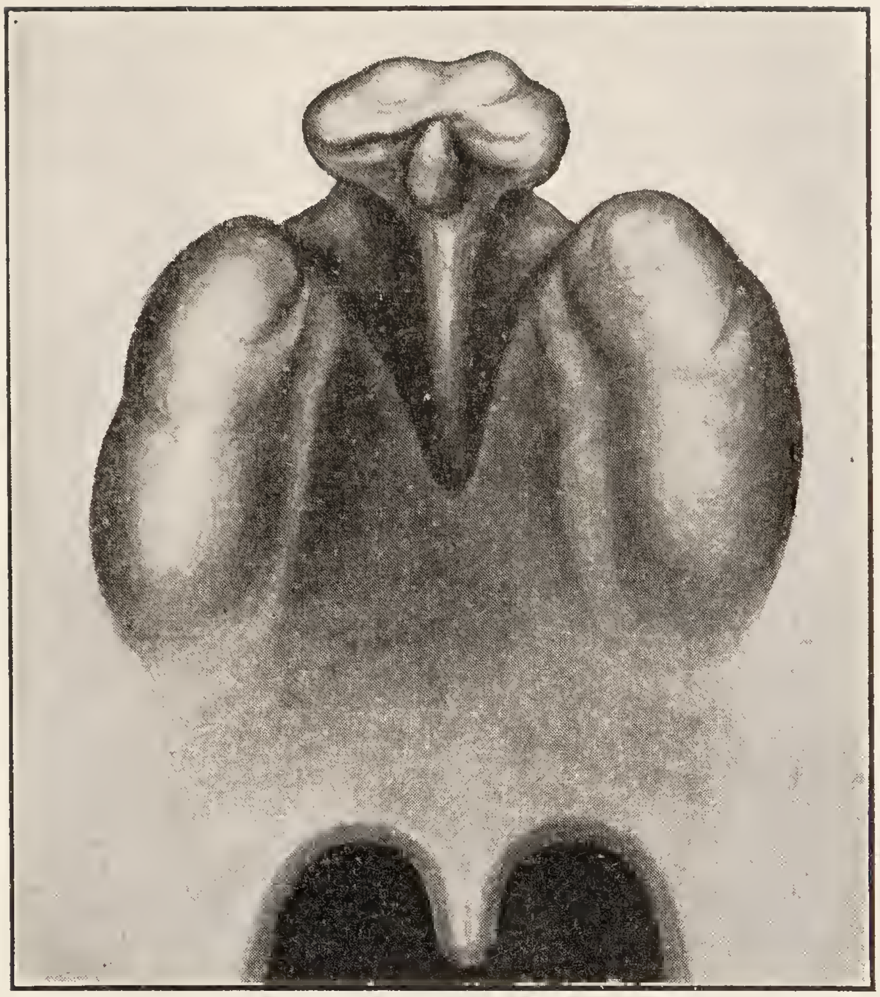


FIG. 424.—Form 12. Cleft of the anterior one-third or one-half of the hard palate with protruding premaxillary bones. The latter are entirely separated from the maxillary bones. This condition is usually complicated with double harelip, partial or complete.

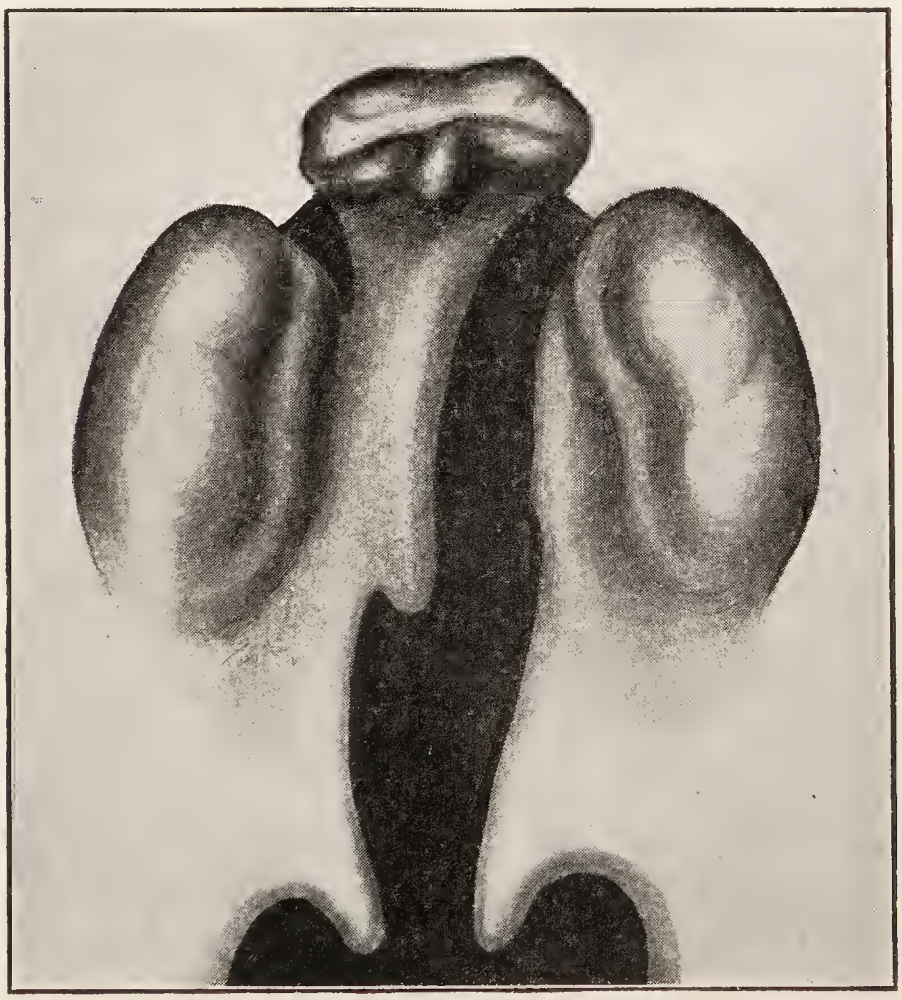


FIG. 425.—Form 13. Cleft of the entire soft and hard palates extending through the left alveolar ridge. The premaxillary bone is partially separated from the maxillary bone on the right side. This condition could be reversed, but the author has never seen such a case.

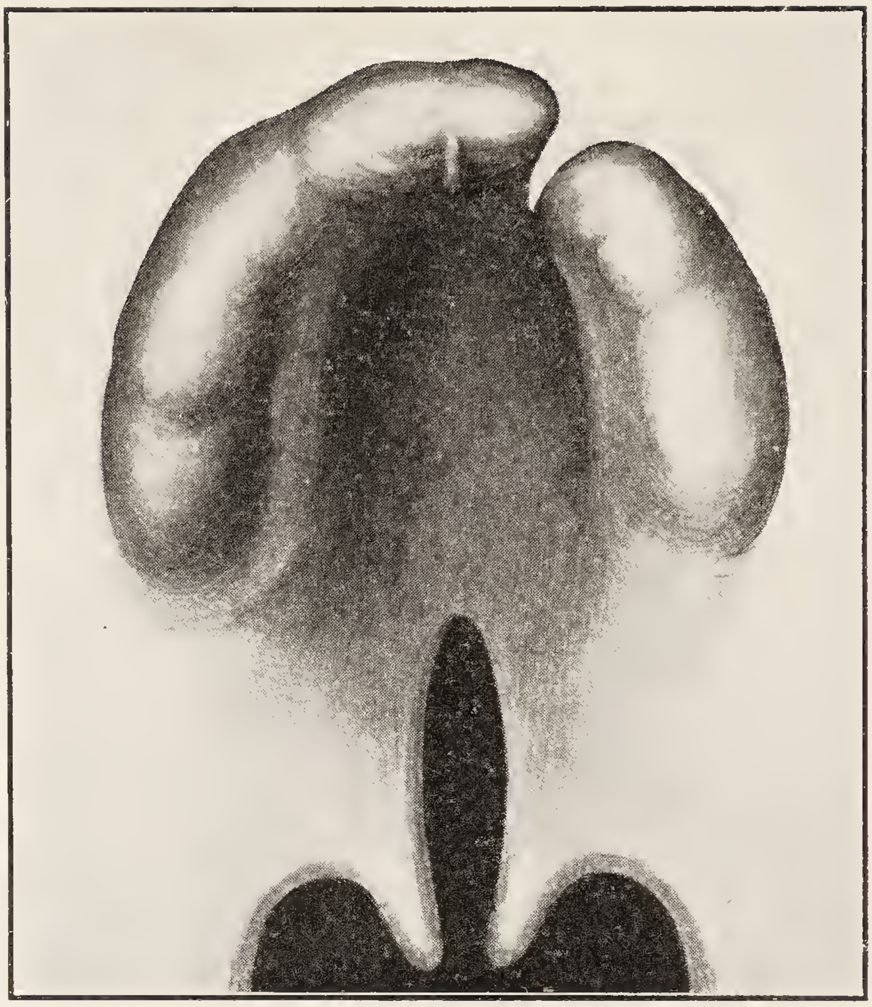


FIG. 426.—Form 14. Cleft of the soft palate, partial or complete, while the hard palate is normal save for a cleft in the alveolar border. The cleft may pass through the alveolar ridge.

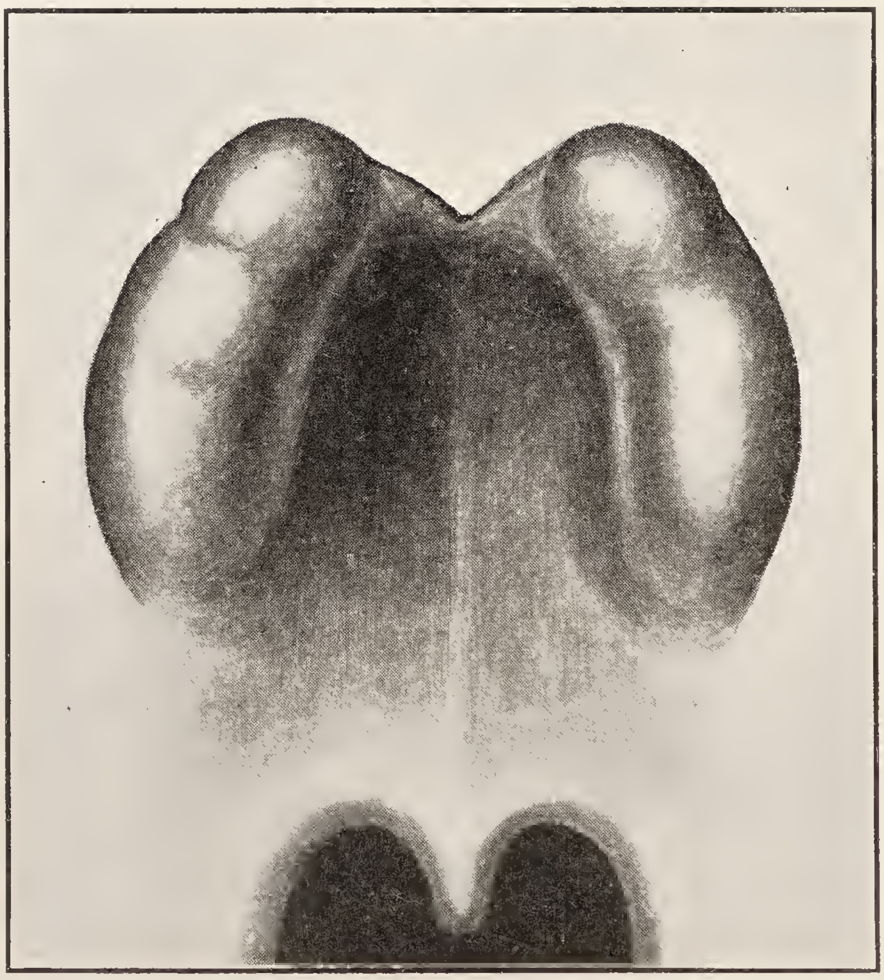


FIG. 427.—Form 15. Cleft only of the alveolar process anterior to the maxillary bones, due to the non-development or absence of the premaxillary bones. Such cases are usually accompanied by harelip. Occasionally only a slight notch is found in the alveolar border. In one case in the author's practice, it was accompanied by single harelip in the median line.

from the maxillary bones. This condition is usually complicated with double harelip, partial or complete (Fig. 424).

Form 13. *Cleft of the entire soft and hard palates extending through the left alveolar ridge. The premaxillary bone is partially separated from the maxillary bone on the right side* (Fig. 425). *This condition could be reversed, but the author has never seen such a case.*

Form 14. *Cleft of the soft palate, partial or complete, while the hard palate is normal save for a cleft in the alveolar border. The cleft may pass through the alveolar ridge* (Fig. 426).

Form 15. Cleft only of the alveolar process anterior to the maxillary bones, due to the non-development or absence of the premaxillary bones (Fig. 427). Such cases are usually accompanied by harelip. Occasionally only a slight notch is found in the alveolar border. In one case in the author's practice, it was accompanied by single harelip in the median line (Figs. 235 and 236).

TREATMENT OF PALATAL DEFECTS IN PATIENTS BEYOND THE AGE WHEN TRANSFIXION OF THE BONES IS EXPEDIENT

In the previous pages, I have pointed out the fifteen forms of congenital cleft palate, and I will treat them in the order named.

Form 1.—*Cleft of the Uvula*, Fig. 413. This is the simplest form of cleft palate and, consequently, the most easily corrected. Many patients go through life with this defect without receiving surgical treatment with no embarrassment and without attracting attention since their phonation is usually perfect. In some cases, however, defective speech is observed. If only the uvula is involved, it may be quite as well to let it remain so, for the reasons stated. A demand is made sometimes for an operation. This should be done, preferably, at the age of fourteen to eighteen months. It may be done at any age, but the suggested time is best.

Surgical Technic.—With the patient's head covered and protected by a sterile cap or towel, the face and neck thoroughly sponged with an antiseptic solution, the tongue is drawn forward by the use of the forceps (Fig. 508), and the oral speculum (Fig. 500) adjusted. After sponging the throat and removing mucus from the nose as well as the pharynx, the operator seizes the tip of the left half of the uvula, pulls it forward and splits its edge. The right side is treated in the same manner. Splitting this muscular tissue serves a better purpose than paring the edges, since freshened surfaces are secured sufficiently broad to unite without loss of tissue. Horsehair sutures in small curved Hagedorn needles (Fig. 526) are then carried by means of a Brophy-Truax needle forceps (Fig. 524) through the tip of the uvula and the ends held by forceps outside the mouth. To save time, two needle forceps should be used, the assistant adjusting the needle in one while the surgeon uses the other. Suturing is continued until the necessary number

of interrupted sutures, usually about four, are inserted, after which they are tied (Fig. 428) and the operation is complete.

Form 2.—*Cleft of the uvula, extending forward into the fibers of the levator palati and the reflected portion of the tensor palati muscles* (Fig. 414). In the treatment of this form of cleft, as well as the others hereinafter described, the technic outlined in Form 1, so far as it goes, should be employed; and in those which follow supplemental measures will be used to meet the requirements in each case. In this form of cleft, the uvula is not only divided, but the fissure extends farther into the substance of the soft palate. The edges of the tissues should be split from the tip of the uvula to the anterior extremity of the cleft, care being taken that the splitting is done in such a way that the freshened surface will approach the opposite side after it has been treated in the same manner. The incision should be carried through the mucous membrane and into the muscular tissue. By retraction of the mu-

FIG. 428.—Manner of adjusting sutures in Form 1.

cosa, a freshened surface, sufficiently wide to secure union of the parts after they are approximated, is obtained. Should folds of the mucous membrane along the freshened surfaces seem likely to prevent contact, they should be removed. After the edges of the cleft are well freshened, a properly formed needle (Deschamp's, Fig. 512), curved after the fashion of a gynecologist's needle, is employed and silk pilot sutures introduced through the tissues about midway between the border of the fissure and the alveolar process. With the long clamp forceps (Fig. 510), the stitch is picked up and the needle is withdrawn, or a tenaculum (Fig. 516) may be employed for this purpose. The silk sutures are substituted by No. 22 silver wire, then the lead plates, No. 22 American gauge of suitable length and width, are perforated with holes corresponding to the number of sutures to be placed and shaped so as to extend from near the distal border of the soft palate forward three-fourths of the length of the fissure. The lead should be bent to conform to the shape of the palate. The wire sutures are then passed through

the holes in the lead plate, adjusted to the palate and twisted together. Two sutures are required in this fo m of cleft. Before the lead plates are fixed in place, as a matter of convenience, coaptation sutures of horsehair should be introduced, but not tied until the edges are approximated by the tension of the wire sutures and lead plates. In favorable cases this form of cleft may be treated as described in Form 1.

Form 3.—*Cleft extending through uvula and forward to the posterior border of the horizontal plates of the palate bones* (Fig. 415). Before I employed silver sutures and lead plates, I experienced the same disappointments common to others inasmuch as the sutures frequently cut out and the operation was a failure. I regard the use of the lead plates and silver tension sutures essential

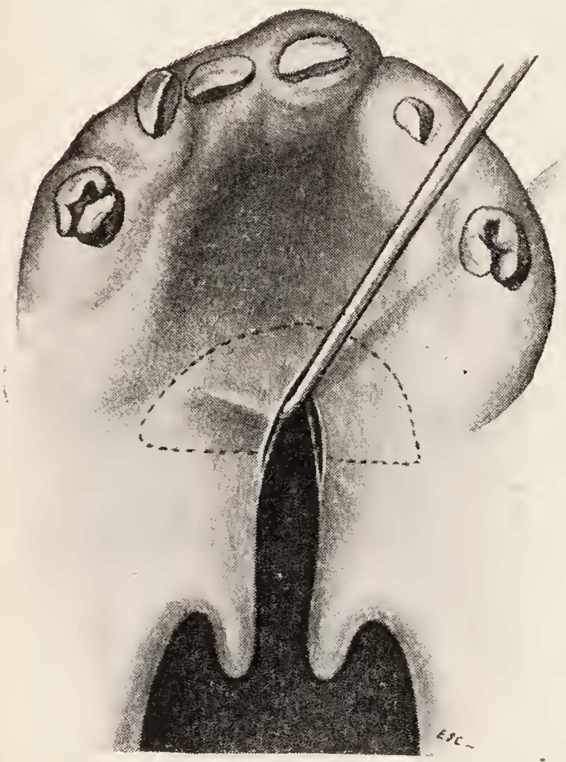


FIG. 429.

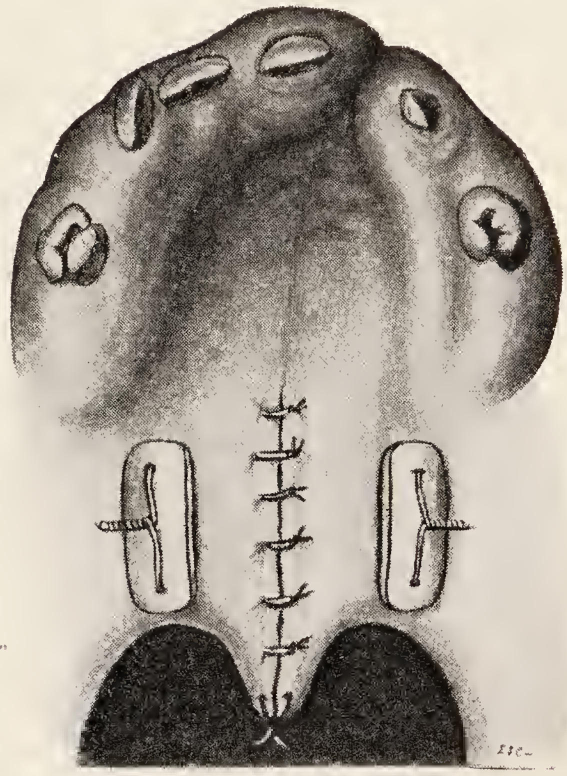


FIG. 430.

FIG. 429.—Method of elevating the muco-periosteum from the hard palate and separating it from the posterior border of the horizontal plate of the palate bones. This illustrates a Form 4 cleft as well as the final operation in a Form 7 cleft.

FIG. 430.—Operation completed. This is the last operation to be performed in a Form 7 cleft palate.

to success in the treatment of this form of cleft. The late Professor Garretson of Philadelphia expressed the views of most authors on this subject when he said: "In looking over the history of staphylorrhaphy, the reader will be struck with the likeness in complaints, the three principal of which seem to be the difficulties in tying the sutures, their tendency to cut out after they are once nicely tied and the concealment of the parts during the operation, both because of deficiency of light and the accumulation of viscid muco-saliva, which, in mouths thus affected, is secreted in great abundance." Further he states: "As generally practised, it is rather difficult of performance and so frequently unsuccessful that surgeons seem disposed to avoid the responsibility of it." In addition to the complaints above enumerated, hemorrhage has been regarded as a serious complication during the operation.

The preparation of the edges of the cleft, the use of the lead plates and wire sutures are the same as described in Form 4. If the soft parts in the anterior extremity of the fissure meet, the suturing of them may be accomplished easily. If we find them separated to such an extent that we cannot approximate the edges without first lifting the periosteum from the palatal surfaces of the bones forward (from one-fourth to one-half inch), we make use of the periosteal elevators and lift the tissues.

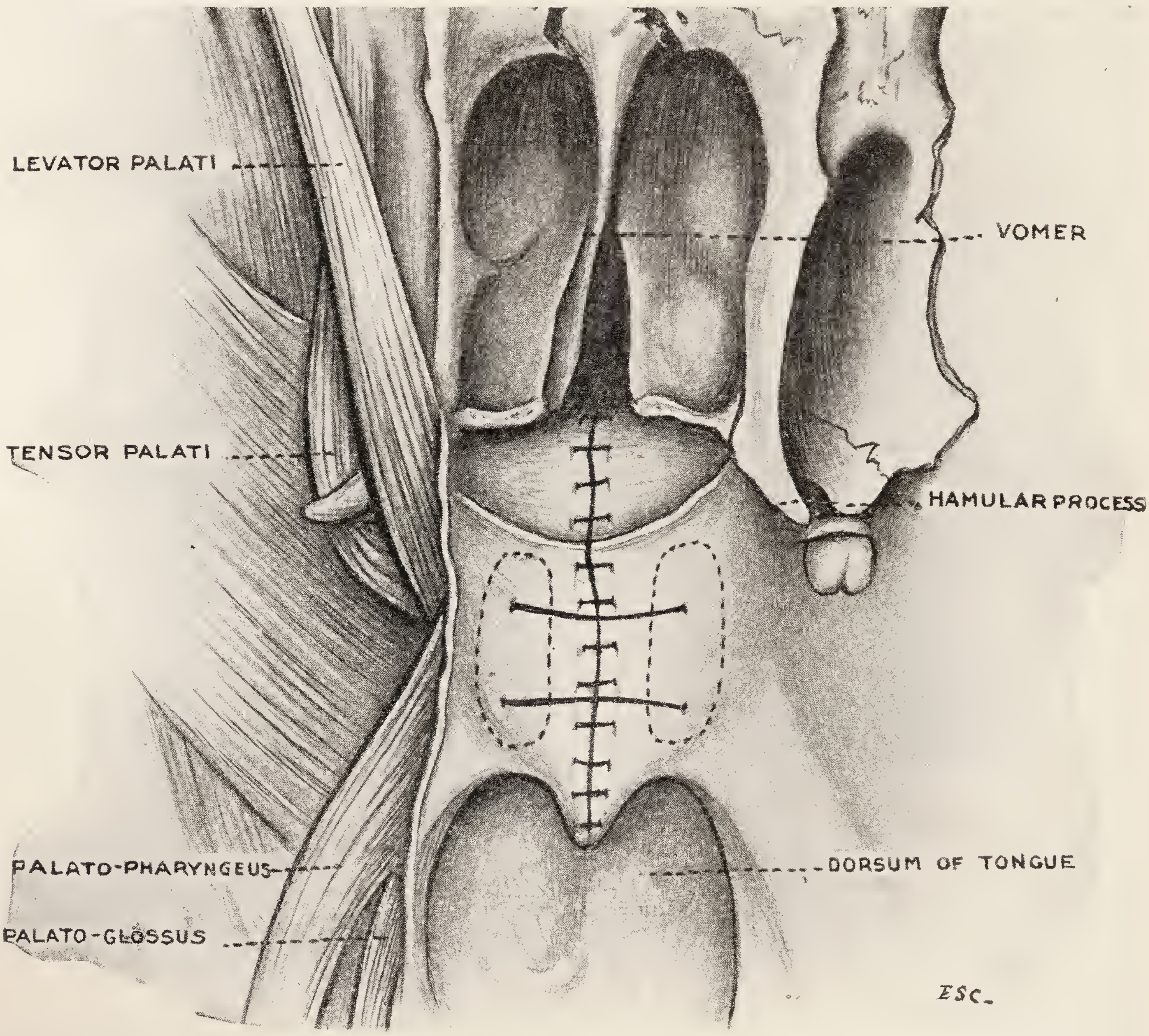


Fig. 431.—Posterior view of soft palate showing correct method of placing wire sutures. The lead plates on the anterior surface are represented by dotted lines. Sutures should not be placed through tissues removed from bone.

Form 4.—*Cleft extending through the entire soft palate, including partial or complete cleft of the horizontal plates of the palate bones* (Fig. 416). We meet in this form of cleft a condition calling for steps not usually necessary in the preceding forms. Here we use instruments to denude the bone of the mucoperiosteum along the borders of the cleft and a little way forward of the anterior extremity of the fissure. The first step is to use the curved periosteotomes (Fig. 507). I designed these instruments of different sizes and angles to meet the requirements of individual cases. The instrument should

be carried back into the cleft and above the soft palate, brought in contact with the distal border of the horizontal plates of the palate bones and the muco-periosteum divided (Figs. 429 and 430). The instrument is then carried forward along the entire length of the border of the cleft and the periosteum removed on both sides of the fissure. By lowering these tissues from the hard palate, the U-shaped anterior extremity of the cleft (Fig. 434) will be converted into the form of the letter V (Fig. 435). We are now able to bring the edges of the cleft into contact throughout its entire length. It will be observed that by removing the periosteum from the borders of the fissure and dividing it above the velum and at the posterior border of the horizontal plates of the palate bones, the operator is not only able to bring the edges of the cleft easily into contact, but he *lowers the vault of the palate and, at the same time, lengthens it so that it more nearly or quite approaches the posterior pharyngeal wall.*

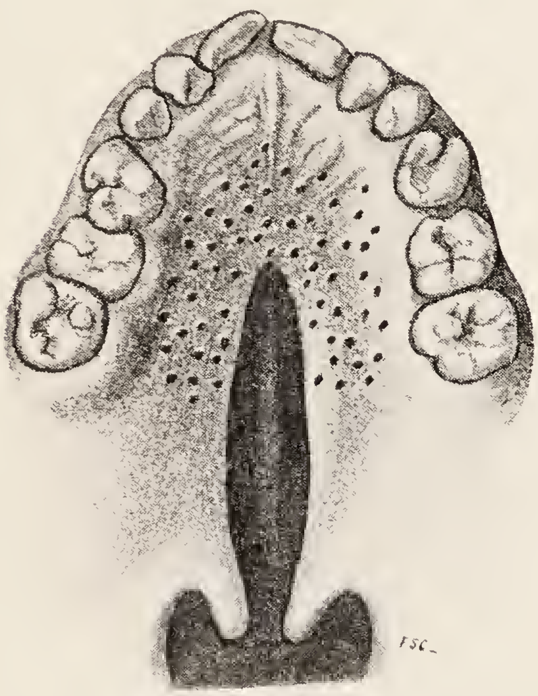


FIG. 432.—Ferguson's method of treating thin palate.

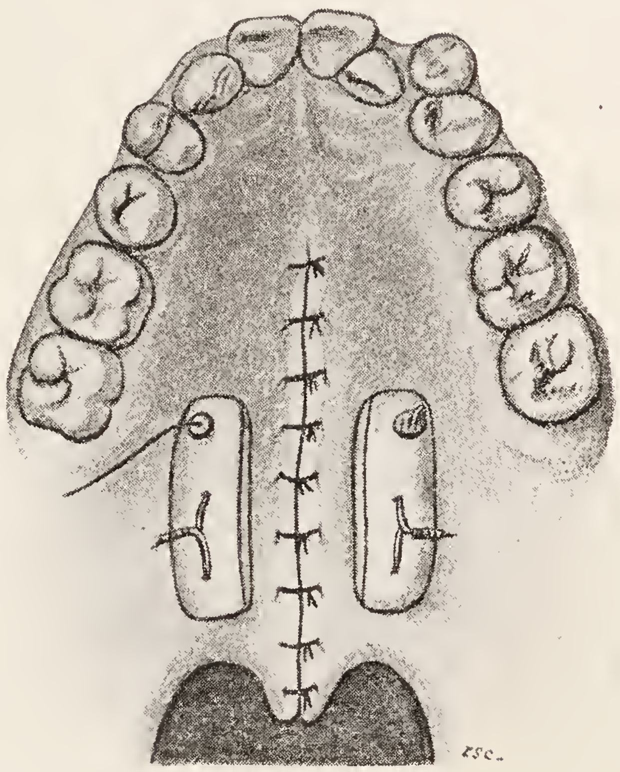


FIG. 433.—Fixing the third wire (one without a mate) with lead shot with a hole through it.

It has been observed by all operators that the muco-periosteum covering the hard palate is, in some cases, exceedingly thin at the posterior border of the horizontal plate of the palate bone. In other words, there is very little connective tissue intervening the periosteum and the mucous membrane. It is important, therefore, to avoid passing the needle through this thin portion. It should be passed posterior to it (Fig. 431). This precaution must be observed since the tension of the sutures on this thin tissue may lacerate it and leave an opening which will require subsequent operation to close. To thicken these tissues the late Alexander Hugh Ferguson practised a line of treatment preliminary to operation, which is as follows:

He made use of a sharp pointed steel instrument and perforated the soft

parts covering the hard palate under local anesthesia. The connective tissues then became much thicker (Fig. 432). It is very apparent that thicker

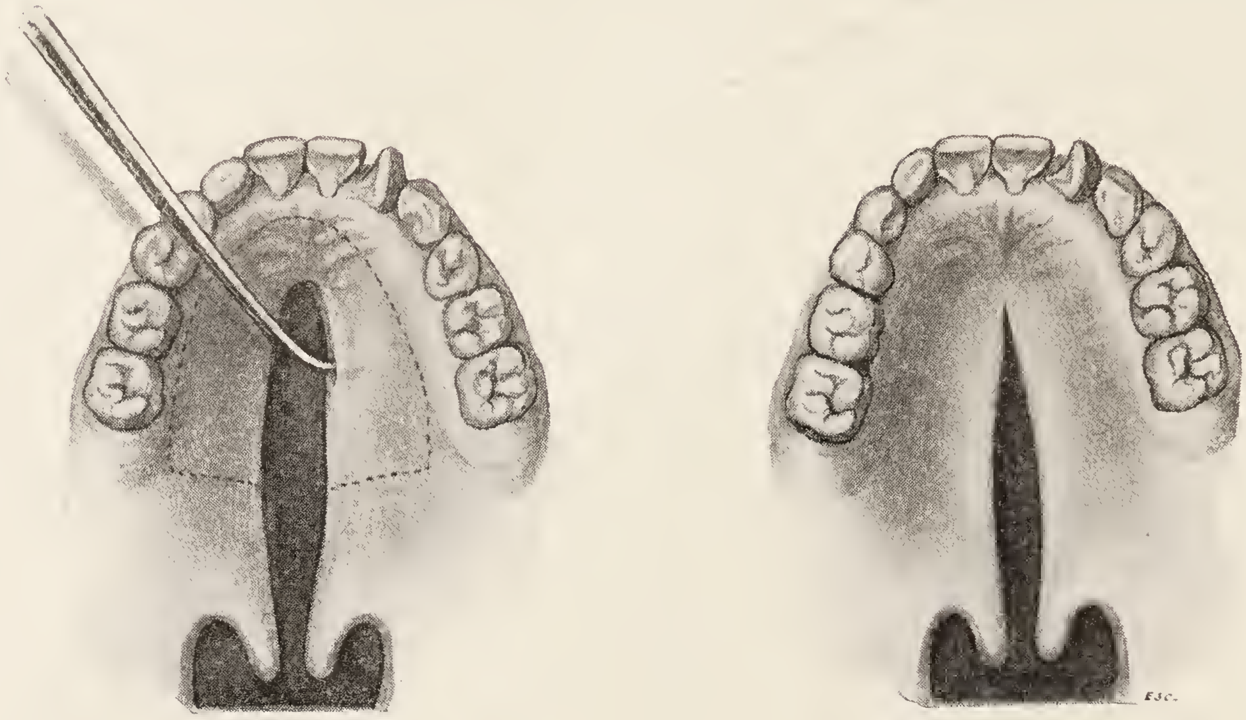


Fig. 434. Fig. 435.

Figs. 434 and 435.—The U-shaped cleft converted into a V by the use of the periosteal elevator.

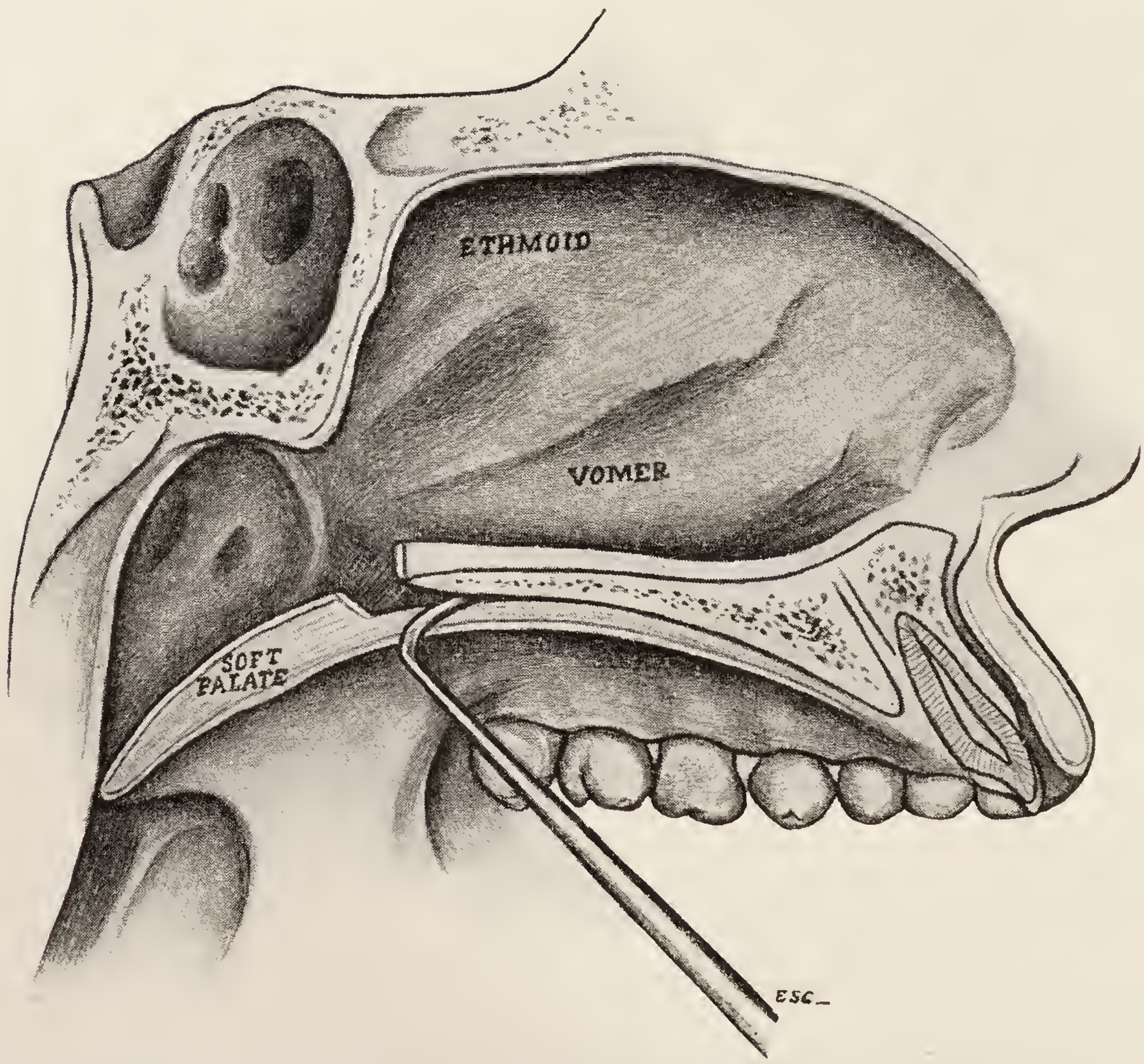


Fig. 436.—Dividing the nasal muco-periosteum from the posterior border of the horizontal plates.

surfaces will unite more readily and make a stronger, and more substantial palate. My experience convinces me that Dr. Ferguson was correct.

The number of wire sutures used to fix the lead plates in this form of cleft varies from two to four; occasionally, a greater number will be required. Should three sutures be used, the mates are to be twisted together, while the one without a mate should be fixed by means of perforated shot (Fig. 433).

Form 5.—*Cleft of the entire soft palate, extending through the horizontal plates of the palate bones and into the palatal processes of the maxillary bones* (Fig. 417).

The treatment of this form does not differ materially from *Form* 4. It

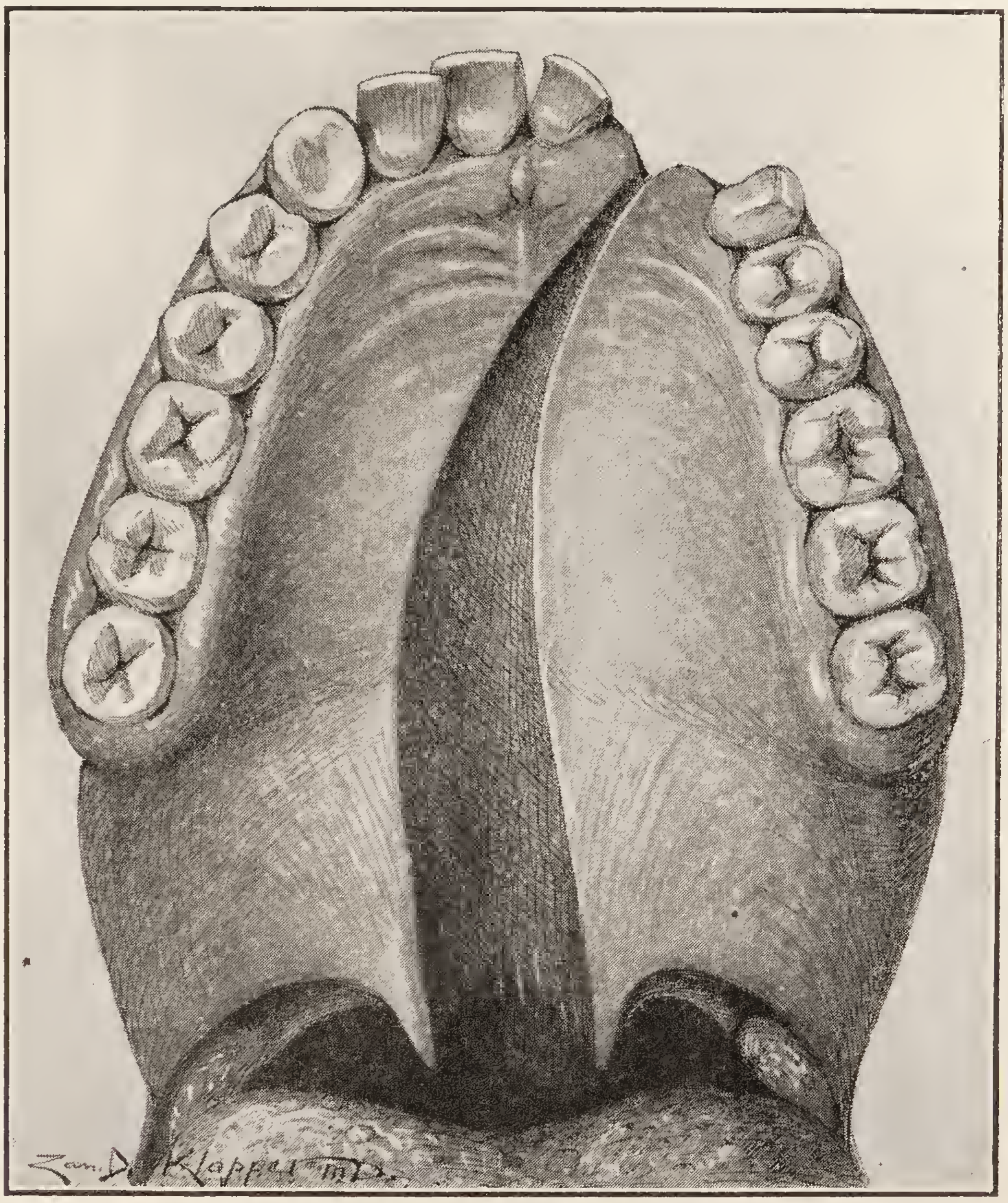


FIG. 437.—Palatal surface of adult's mouth showing congenital cleft of hard and soft palates.

consists in elevating the muco-periosteum in the same manner, but the bone is denuded further forward than is called for in *Form* 4. Two wire sutures are almost invariably employed. As in the other forms, the borders of the cleft must be freshened throughout the entire length.

Form 6.—*Cleft of the entire soft palate including the hard palate as far forward as the original line of union between the palatal plates of the maxillary bones and the premaxillary bones* (Fig. 418).

In this form it is necessary to use the curved periosteotome and to denude the hard palate of the periosteum from the borders of the cleft to the alveolar

processes. This converts the U-shaped fissure to a V (Figs. 434 to 436) and allows the edges to come together, after which plates of lead and silver sutures are used as in other forms (Fig. 433).

Form 7.—*Complete single cleft of the soft and hard palates. The maxillary bone is separated from the premaxillary bone* (Fig. 419).

The operation called for in *Form* 7 depends upon the age of the patient. If he is under five months, the bones may be easily approximated. If the patient is over six months of age, the process of ossification is so far advanced

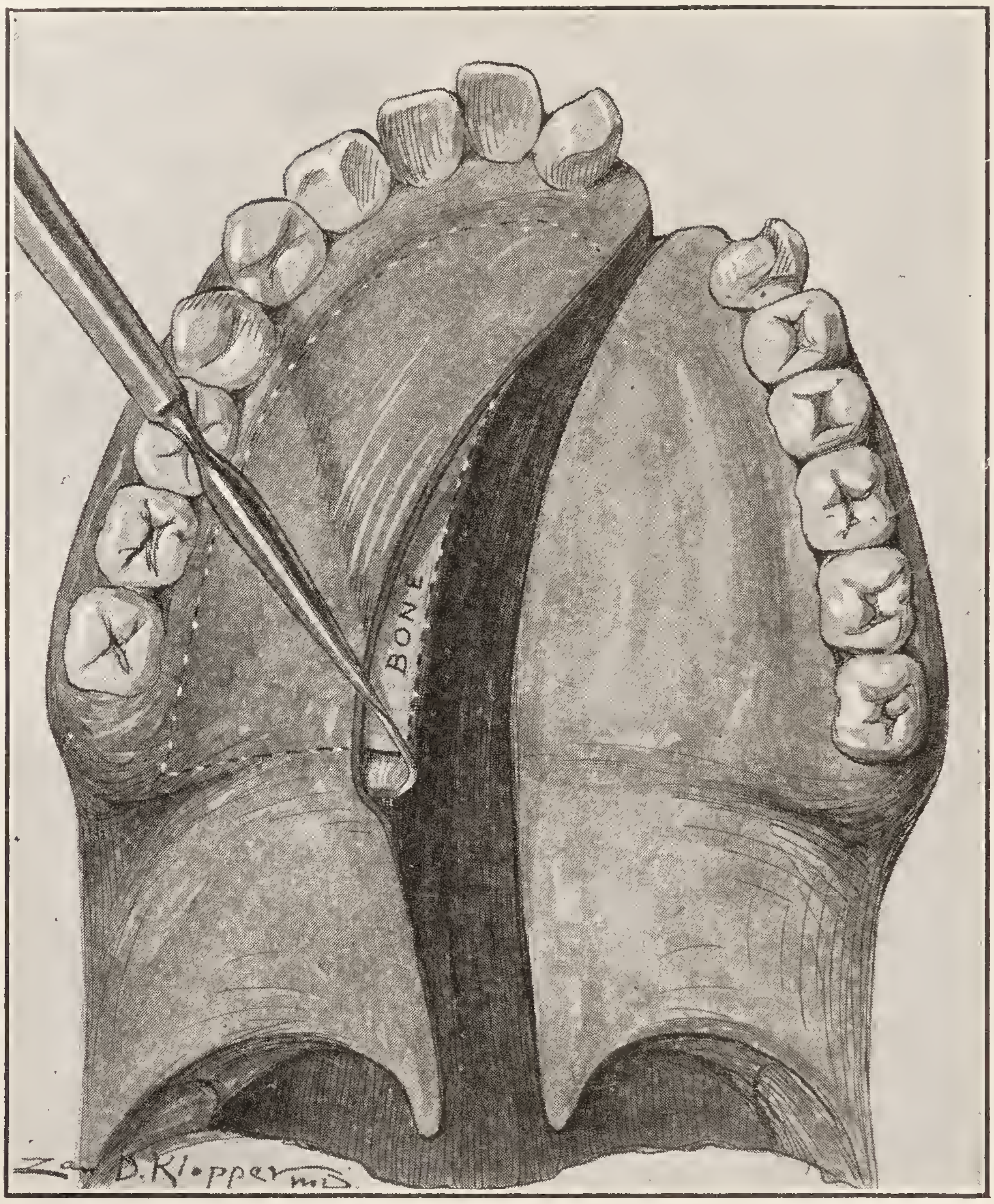


Fig. 438.—Denuding the bone of muco-periosteum. The membranes are lifted as shown by the dotted line.

and the bones are so dense that bending and moving them into contact is not expedient. They may be approximated in the anterior part of the fissure, however. I would not attempt to move the bones of the palate together except in the most favorable cases after six months of age nor would I perform an operation on the soft palate (with rare exceptions) until the patient is from twelve to fourteen months old. The reason for delaying is that the muco-periosteum removed from the bone is frail and likely to break down. If the child is operated before he speaks, articulation will be correct.

This form may be accompanied by harelip. If the cleft extends between

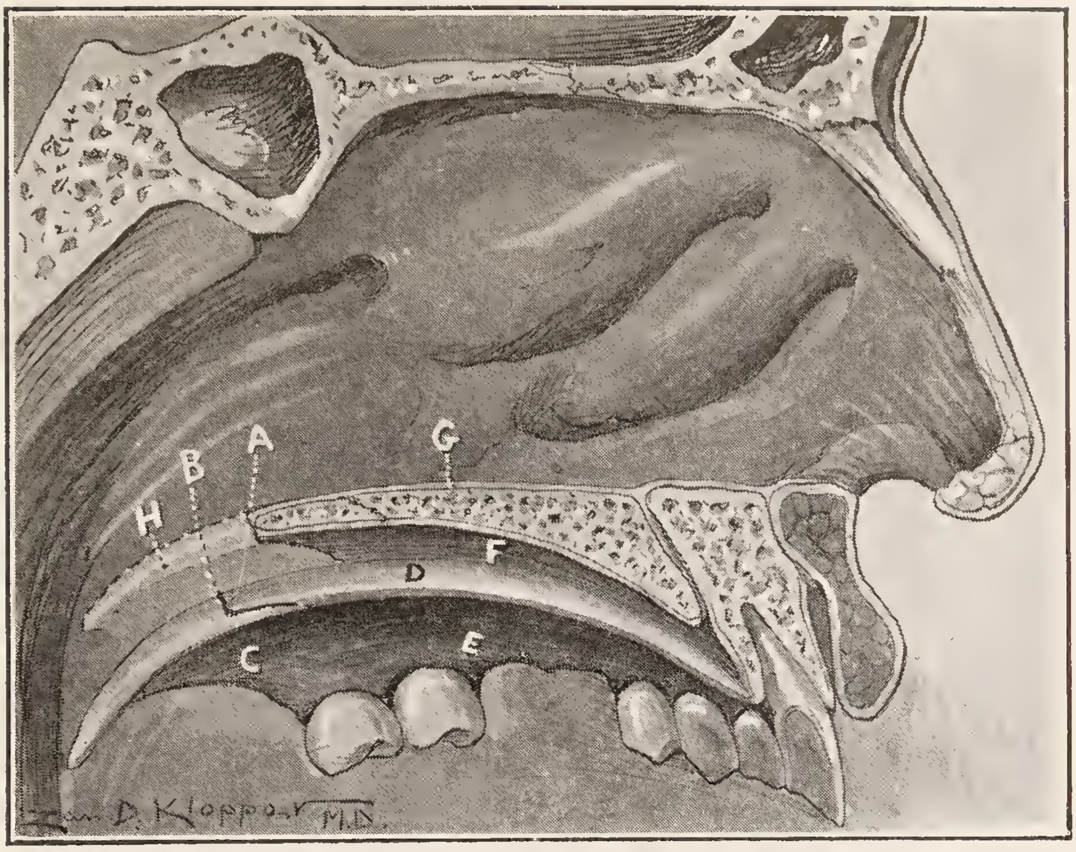


FIG. 439.—Velum separated from the bones and palate lengthened to secure normal function. After the membranes are loosened from the bones, the traction of the palato-pharyngeal and palato-glossal muscles pull the palate downward and backward toward the posterior wall of the pharynx. This makes perfect palatal function possible. It is well known that it is necessary for the palate to close the posterior pharyngeal opening to make certain sounds in articulation perfect. The partially straightened soft parts (*B* and *C*), when released from the bone (*A* and *F*), must necessarily reach further backward than they did when following the curved bony arch.

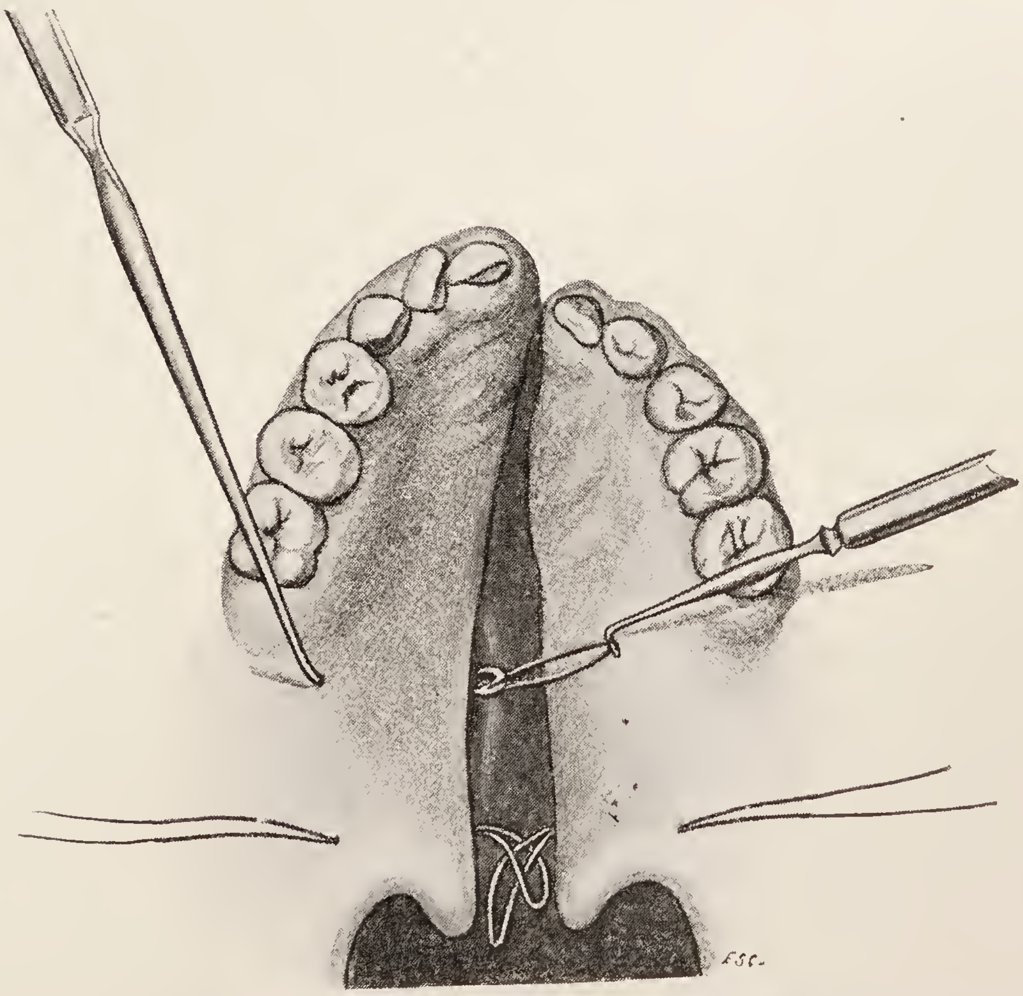


FIG. 440.—Method of introducing silk pilot sutures in soft palate operations. This precedes the introduction of the silver wires.

the left maxillary bone and the left premaxillary bone (Fig. 437), as it most frequently does, the vomer, as a rule, is attached to the hard palate of the right side. The treatment described for *Form* 4 should be employed, varying the procedure so as to meet the requirements of the more extensive deformity. This consists in denuding the bone of the muco-periosteum to the anterior extremity of the cleft (Figs. 438 and 439). The paring of the edges and the introduction of the wire sutures should be carried out as in *Form* 4 (Fig. 430). The lead plates should be longer than in *Form* 6 and the holes in them farther apart (Figs. 441 and 442). Four wire sutures are sometimes employed (Fig. 443). Care must be exercised in avoiding the palatine arteries.

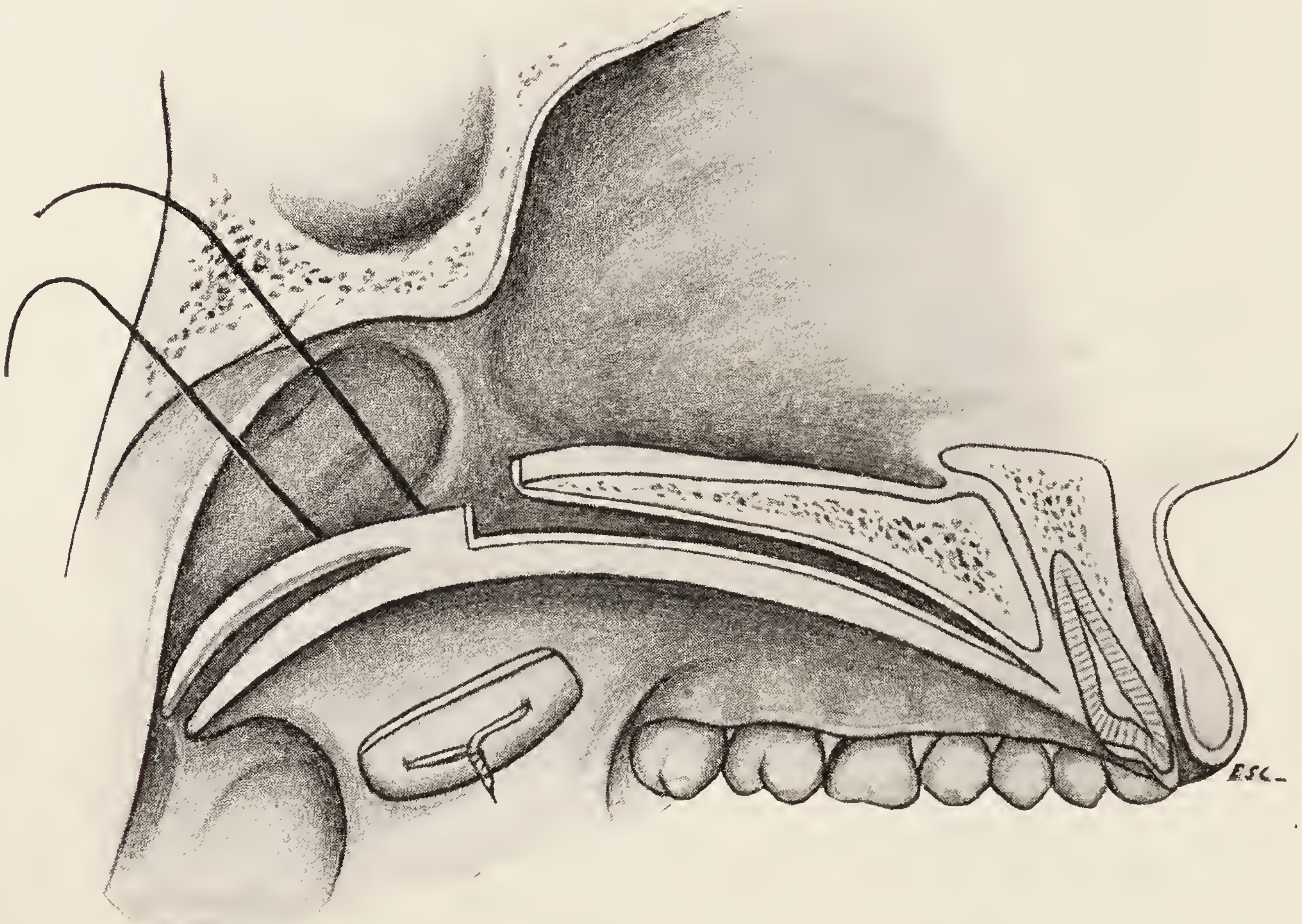


FIG. 441.—Sagittal section of palate showing the left side. With sutures carried through and plate adjusted.

Precaution.—After the lead plates have been placed in contact with the surfaces of the palate and the wires are twisted so as to bring the palate edges together, care must be taken not to twist the wires too tight. If too much pressure is made by the plate against the palate, the circulation may be cut off and the tissues lost. This accident should not occur and will not if the surgeon is cautious in adjusting the plates and carefully examining the sutures to determine that the vessels are not occluded.

The operations described in the treatment of cases coming under *Forms* 1 *to* 7 apply to adults as well as children older than six months. In the treatment of congenital deformities, the surgeon's first duty is to study carefully the condition of the parts and decide what service will remove the deformity and bring to his patient the highest degree of comfort and satisfaction. In

the management of cleft palate, either congenital or acquired, he must decide as to the expediency of an operation, for there are adult patients on whom an attempt to operate would be unwise. With the employment of modern surgical methods in cleft palate operations, we secure as high a percentage of good results as follow other operations. This is a marked improvement over the surgery of twenty years ago, when a large majority of palate operations were unsuccessful, either in failure of union or, if securing union,

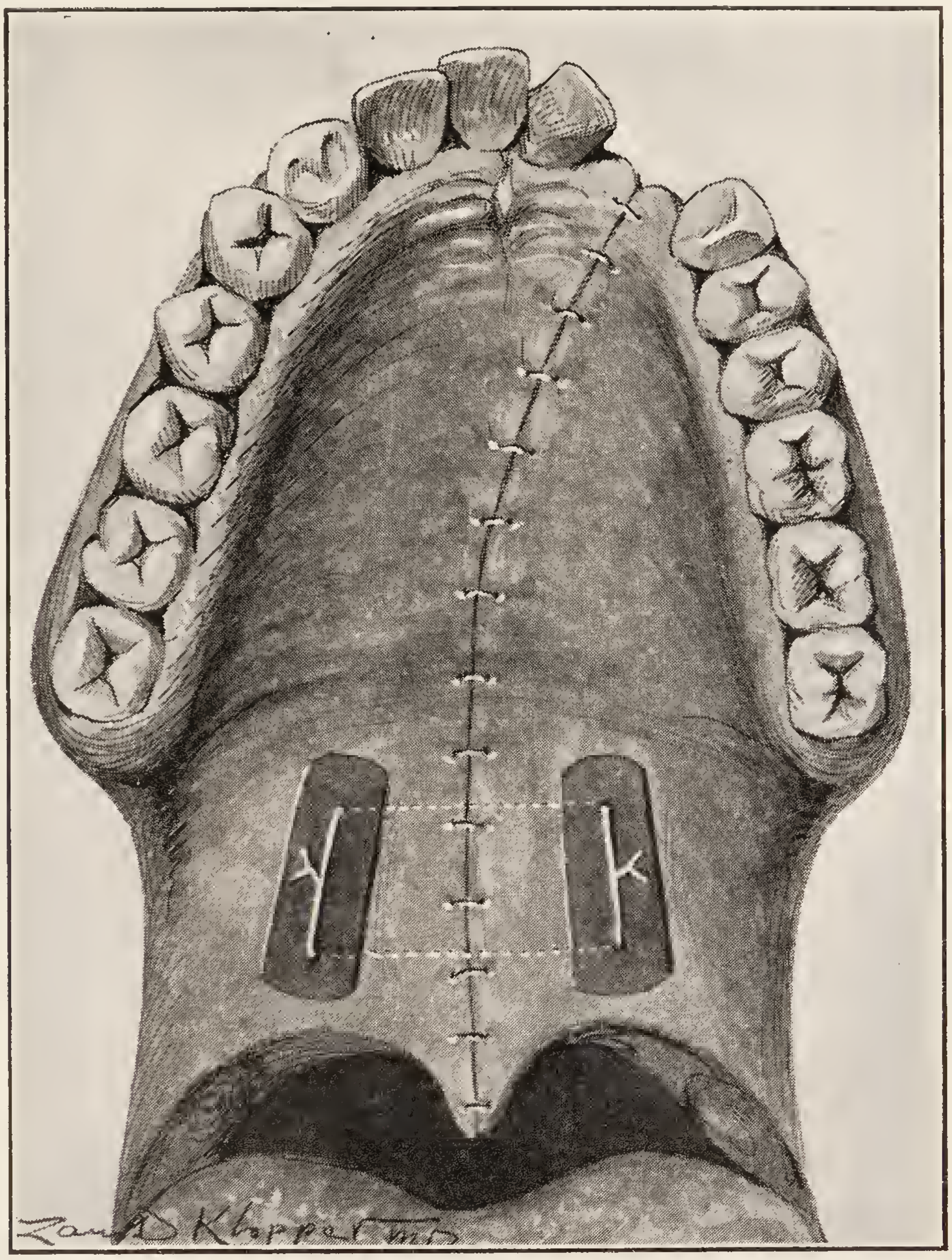


Fig. 442.—Two wire sutures with lead plates are nearly always sufficient. Coaptation horse-hair sutures show in the median line.

failure of function. It is the surgeon's duty, when a case is inoperable, to place his patient in the hands of an expert capable of constructing for him a useful, artificial palate. I regard as inoperable a case in which there is an absence of tissue or one in which there is so little tissue that the construction of a palate surgically would be impossible even though we use the pharyngeal muscles (Fig. 403). These cases are extremely rare. It is in inoperable cases that prosthesis is indicated.

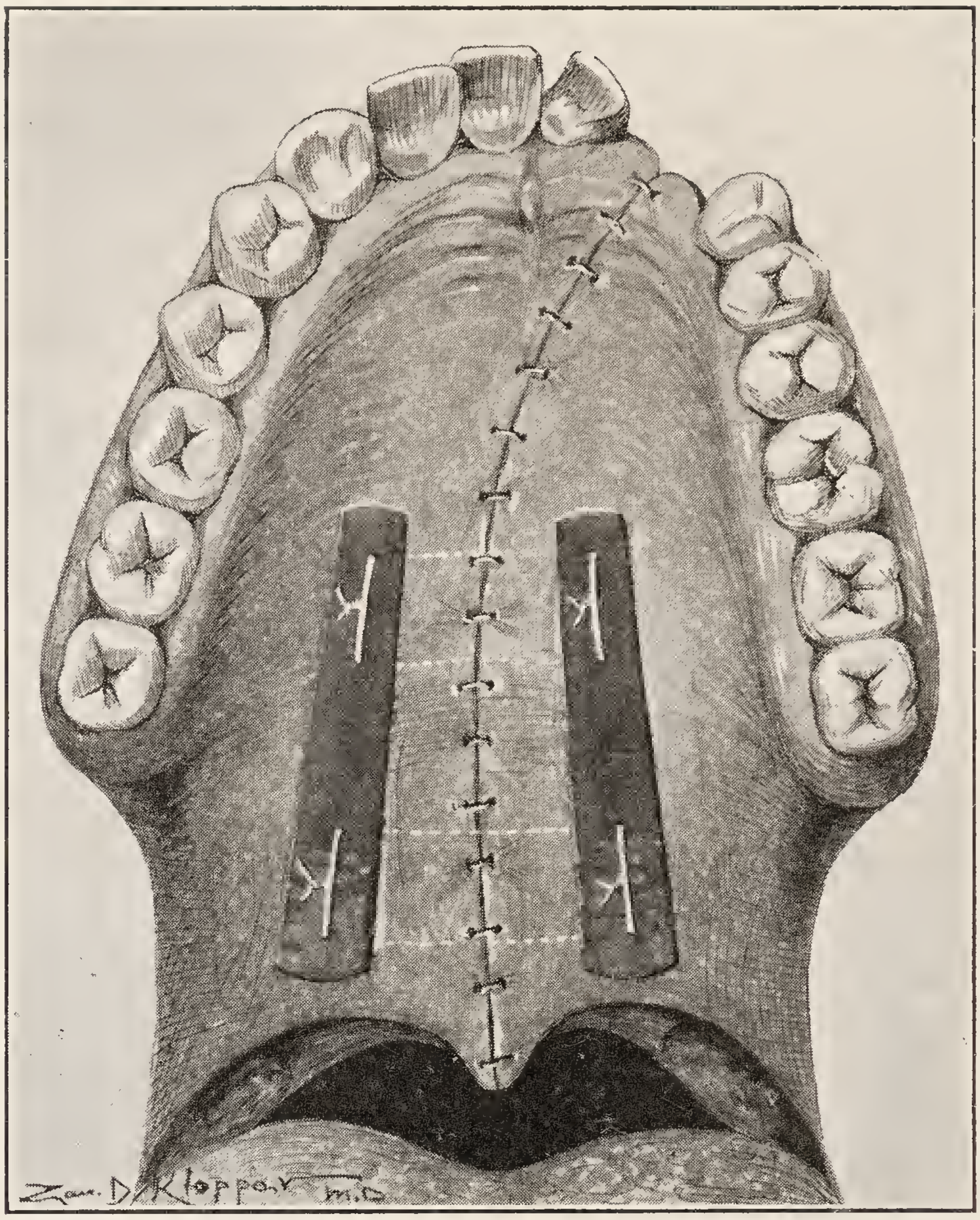


FIG. 443.—Four wire sutures are sometimes necessary in very long palates.

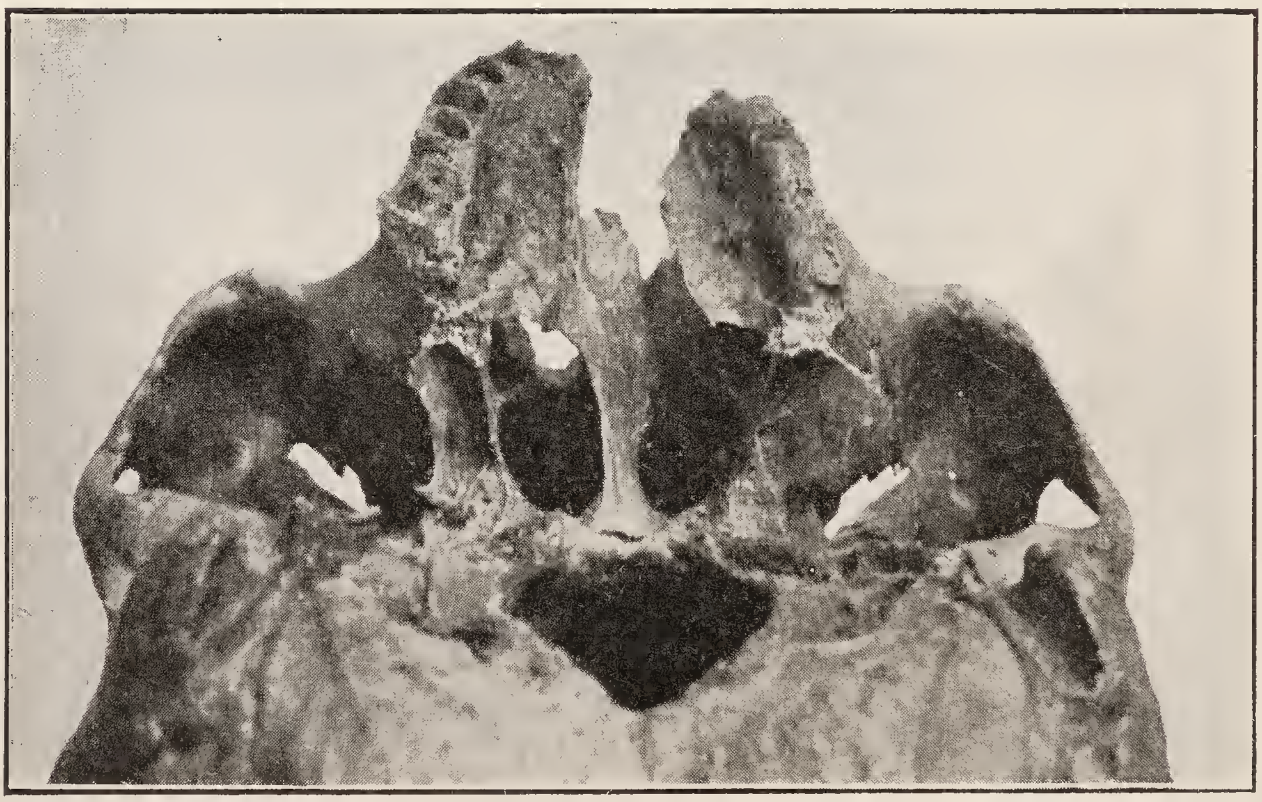


FIG. 444.—Photograph of adult's skull showing cleft of the hard palate. There is no absence of bony tissue. If the bones were forced together the hard palate would be perfect. (*Photograph courtesy Dr. Binnie.*)

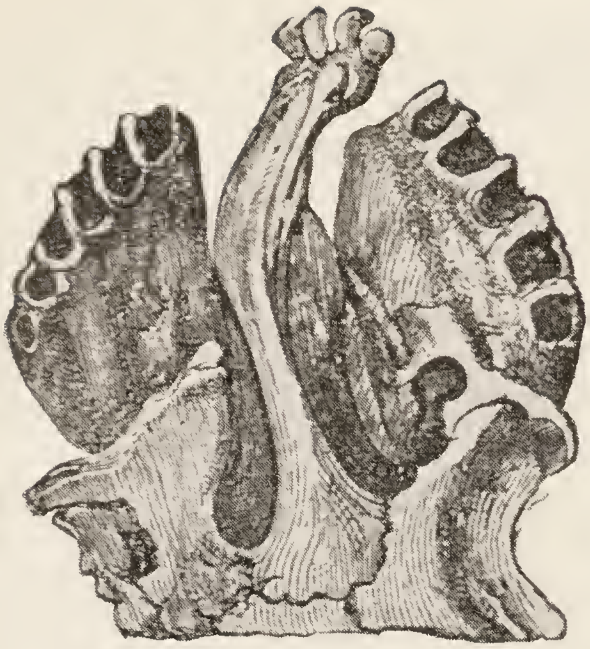


FIG. 445.—Photograph of bones of the upper jaw showing the vomer and premaxillary bones protruding. Abnormally broad arch. If the arch were moved in its proper position the cleft would be closed.

B *A*

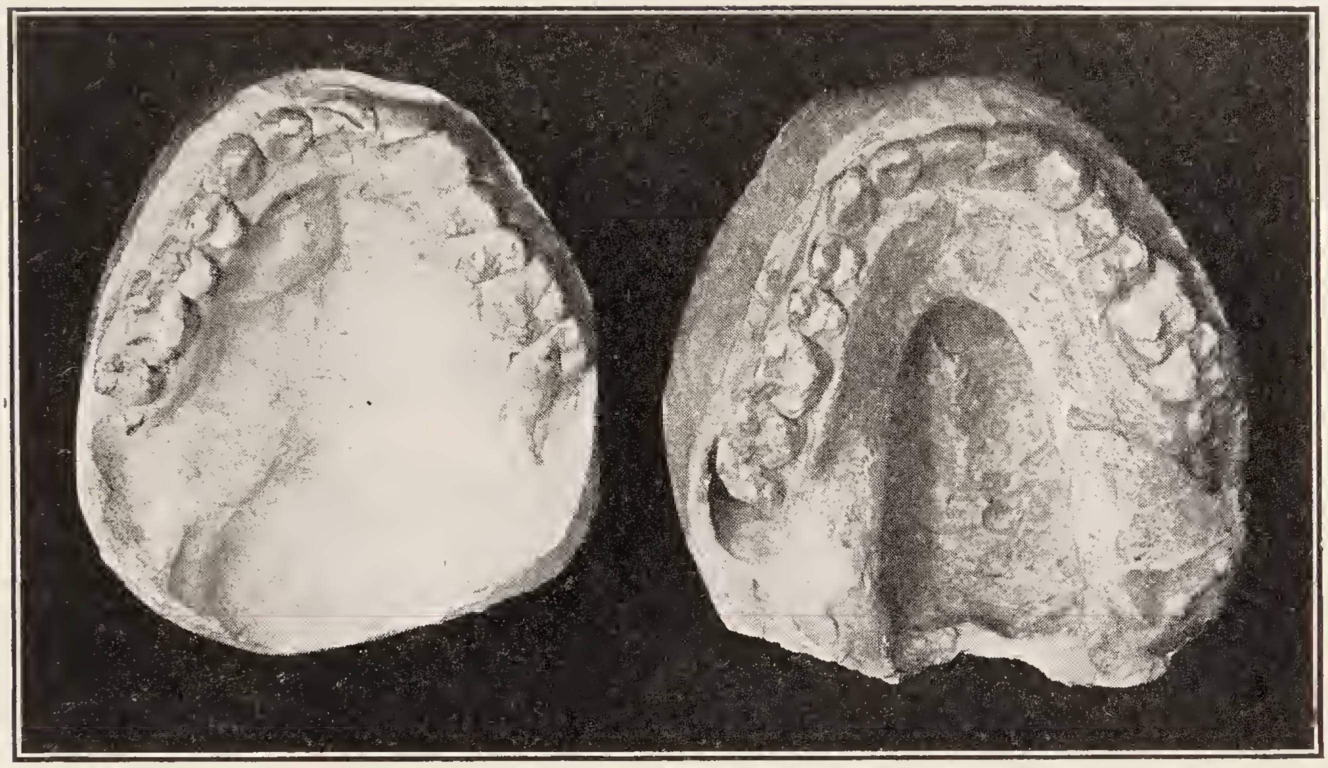


FIG. 446.—Plaster casts before (*A*), and after operating (*B*). A good palate was obtained for this girl without lateral incisions. Form 6 cleft.

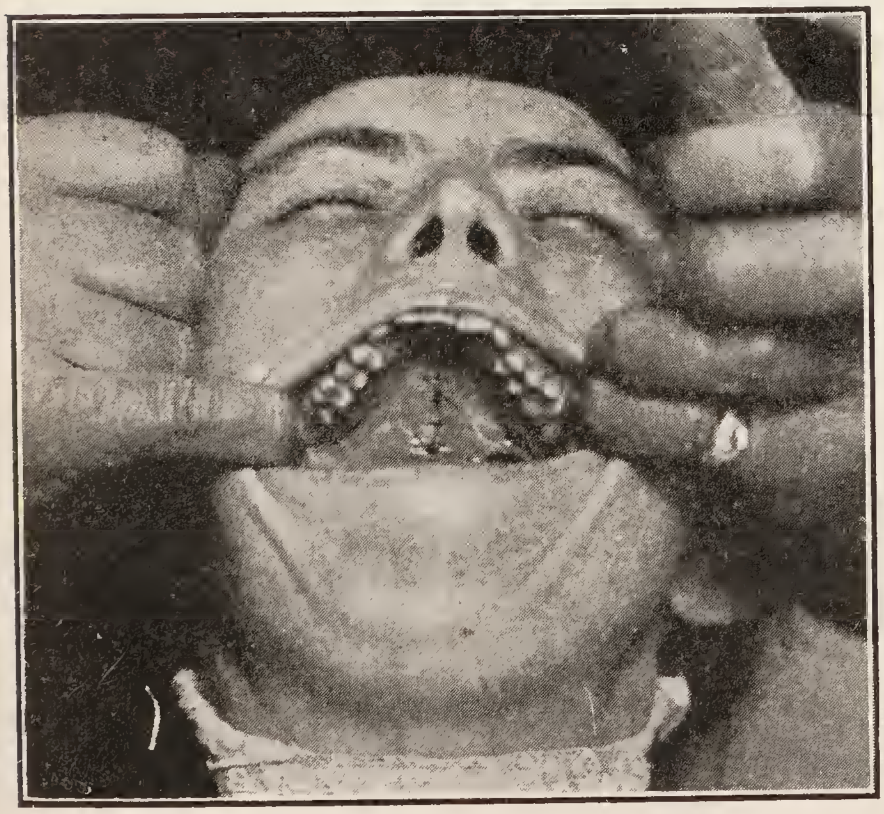
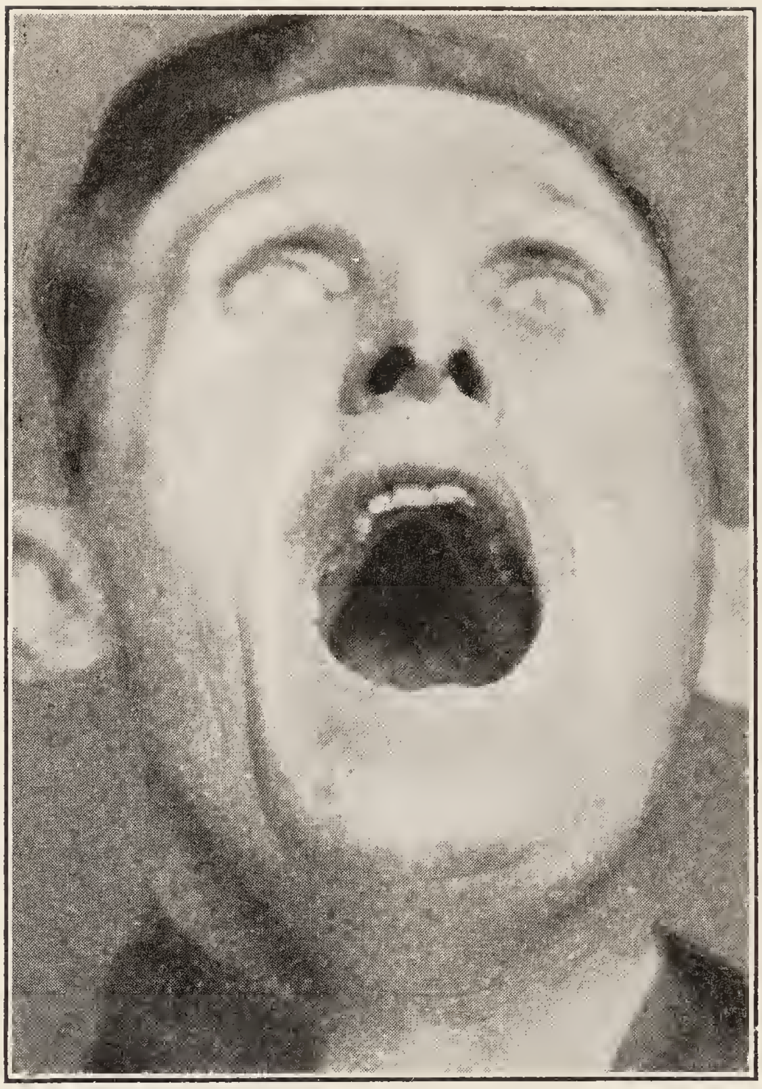
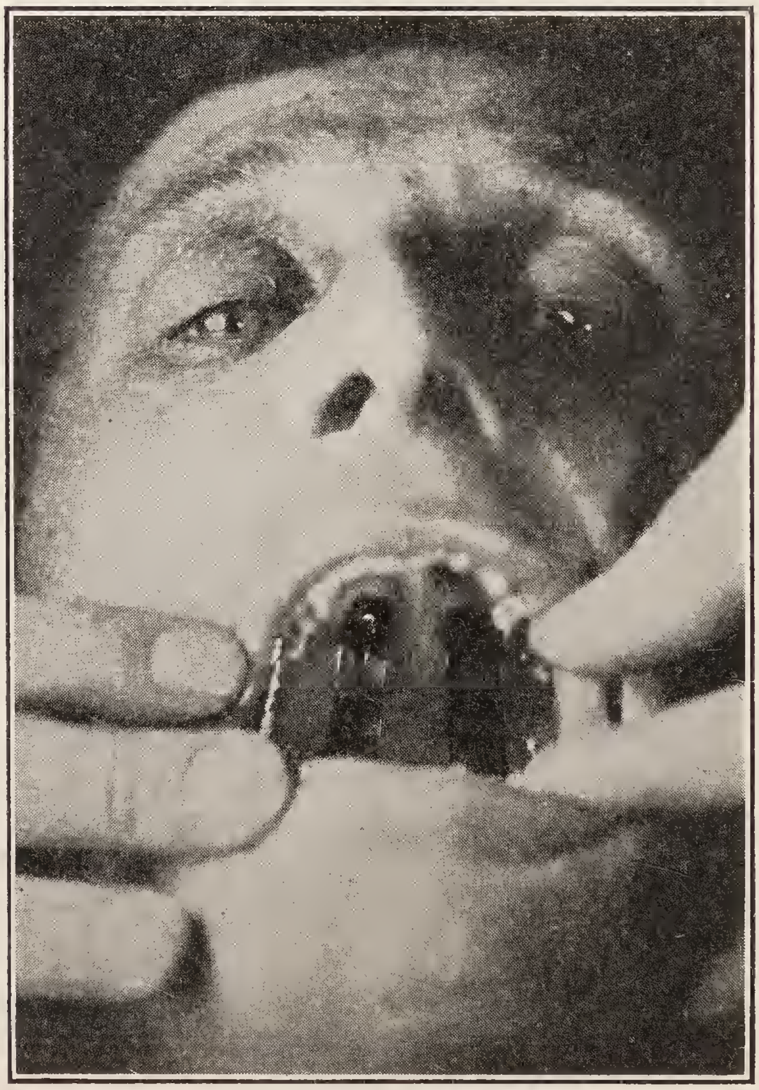


FIG. 447.—This picture clearly shows the result obtained by the author's method of operating cleft palates in adults. The two lead plates are seen just to the inner side of the teeth. The line of horsehair sutures is clearly shown. No tension is placed on them.

Plaster casts of this palate Fig. 446.

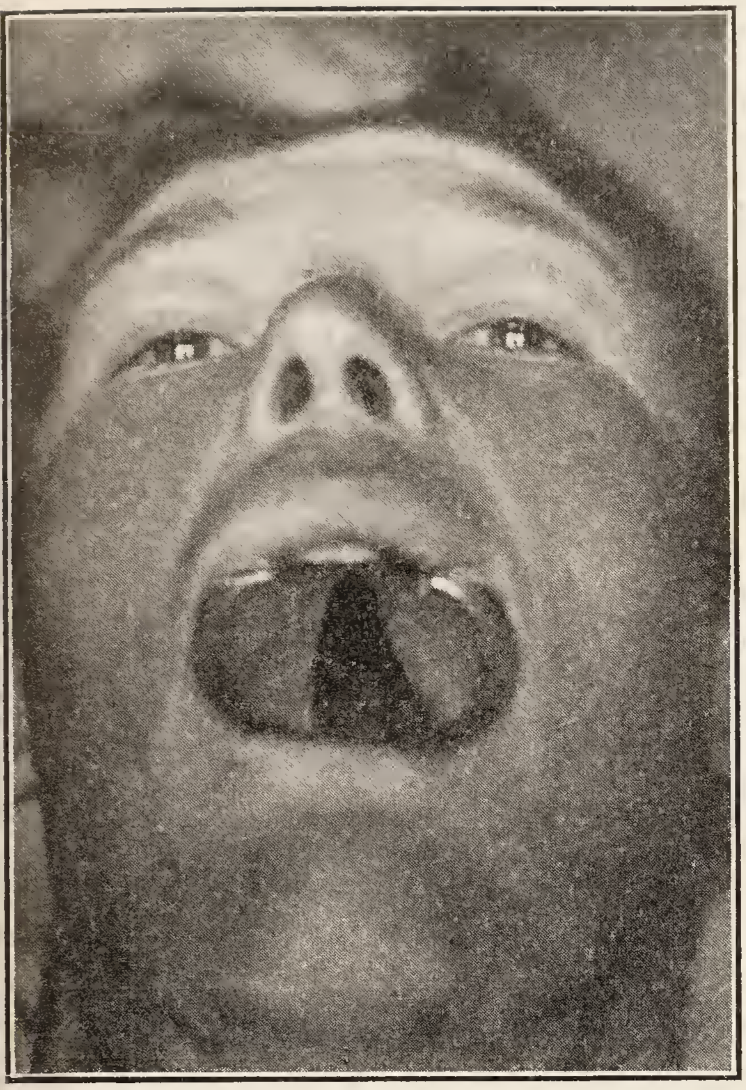


A

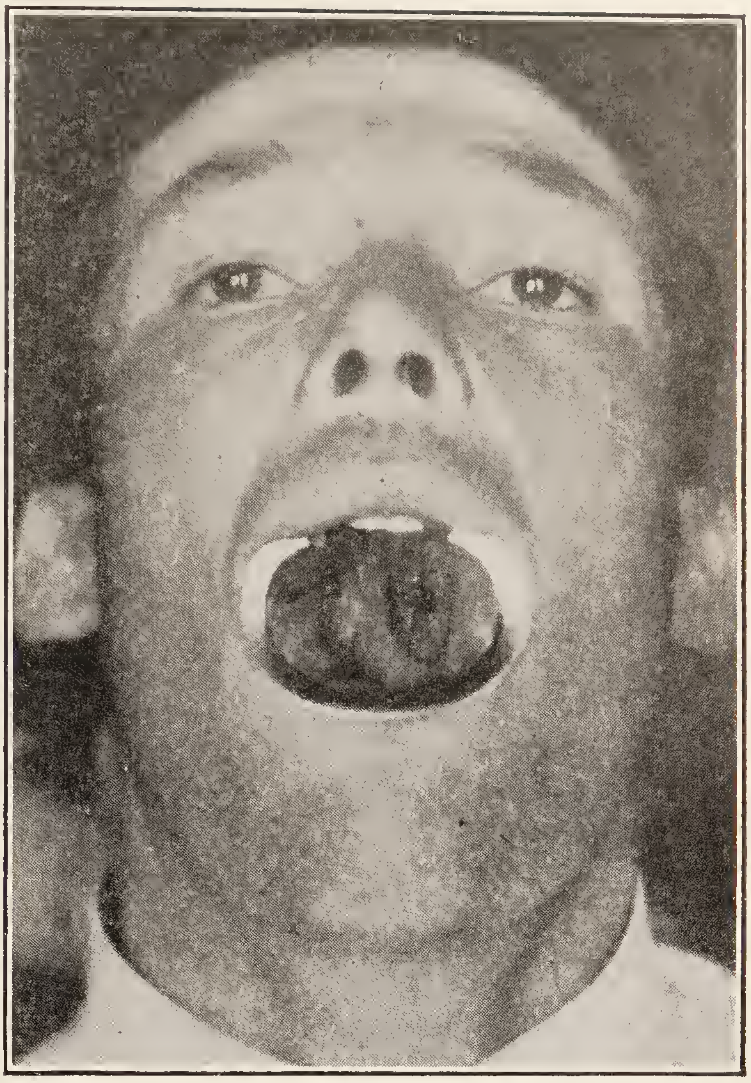


B

FIG. 448.—Extremely wide cleft before (*A*) and after operation. A good result was secured without making lateral incisions. *B*, Palate closed. Lead plates seen upon the surface.



A



B

FIG. 449.—Cleft palate, before and after operation. Lead plates in position. These pictures show the use of the oral speculum.

FIG. 450.—Plaster cast of an adult before and after operation. No lateral incisions were made.

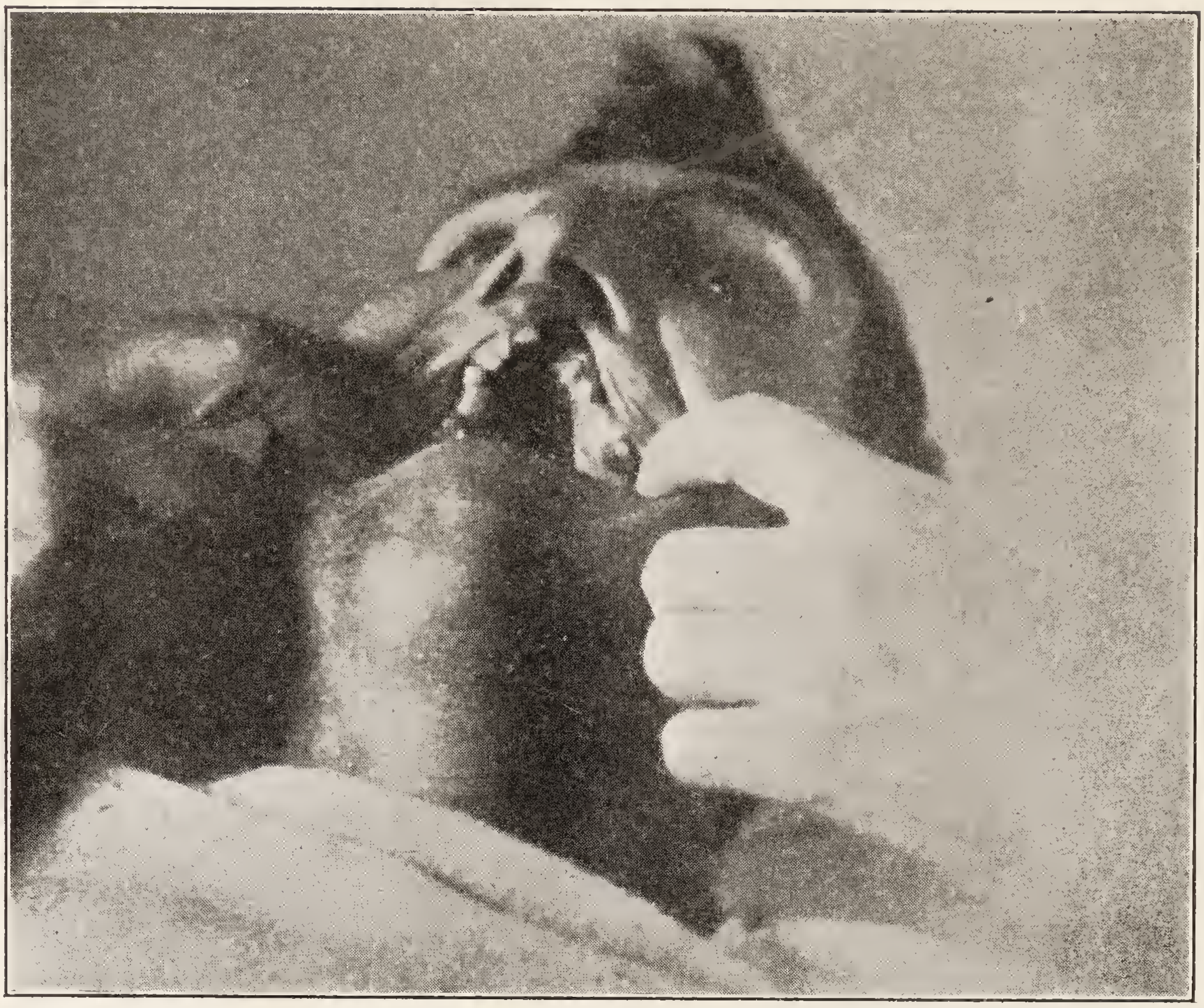


Fig. 451.—Cleft palate and double harelip in a man thirty years of age.

Fig. 452.—Shows palate perfectly united. The lead plates are visible in the soft parts.

FIG. 453.—Illustrates method of approximating the alveolar borders after the patient, unfortunately, had reached an age when the bones cannot be easily bent and brought into proper relation.

A small hole is drilled through the bone between the central incisor teeth and another posterior to the cuspid. Silk pilot sutures are passed with a flexible needle with eye in point, Fig. 528. These are then substituted by wires. The edges of the bone are then freshened by reflecting the soft parts outward. The compact bone is carefully removed. The external plate of the bone is divided with a chisel between the lateral incisor and the cuspid teeth.

A greenstick fracture is thus made. The wires are tightened as the bone is approximated. (*After Blair.*)

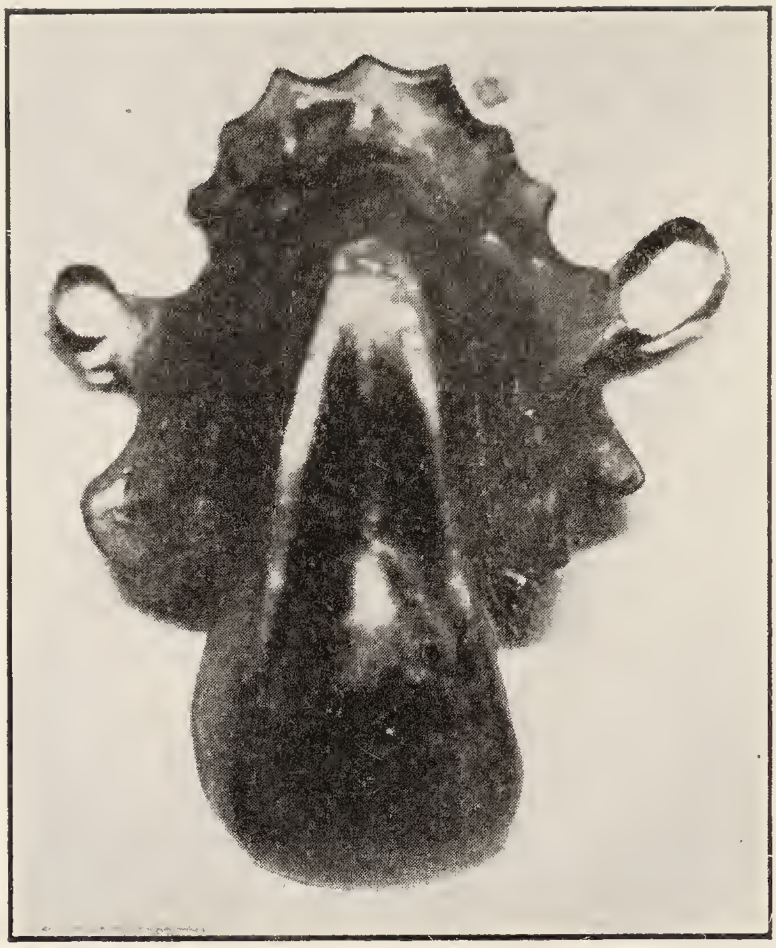


Fig. 454.

Fig. 455.

Figs. 454 and 455.—Obturators which were worn by patients for whom the cleft has been closed with the most satisfactory results.

CHAPTER XXVIII

THE BROPHY CLEFT PALATE OPERATION IN EARLY INFANCY

Experience in employing my operation for the closure of cleft palate at from one week to five months of age has more and more confirmed my opinion and justified the practice. I am firm in my belief that these operations should be done as early as practicable after birth, preferably within the first two weeks. The bones may, however, be moved together without fracture as late as the fifth month. *The operation on the hard palate, when*

FIG. 456.—Broad nostril following defective result of lip operation. Patient also has a cleft palate.

complicated with harelip, single or double, should be made before the operation on the lip. Operations should be made in early infancy for the following reasons:

1. The fissure in the lip enables the operator to gain more room in which to work. The approximation of the separated bones is an operation attended with difficulties far greater than those met in closing the lip, and when covered by the closed lip they are increased.

2. The nose of a patient having single harelip and complete cleft palate, if not operated, permanently remains diverted from the median line towards the side opposite the fissure. It is carried with the long side of the bone, which always protrudes somewhat, away from the center of the face (Fig. 456). Thus early operation straightens the nose at once and brings it into the median line (Fig. 453).
3. The cleft should be closed before ossification of the bones is far advanced, while they may be bent or moved without fracture. Bone at birth is about one-half organic matter, hence it is not difficult to bend the bones and close the cleft a few days after birth (Figs. 457 and 458).
4. The tissues unite kindly and the surgical shock following the operation is not so great if it is performed within the first month as it would be later in childhood. It is a well established physiological fact that the nervous

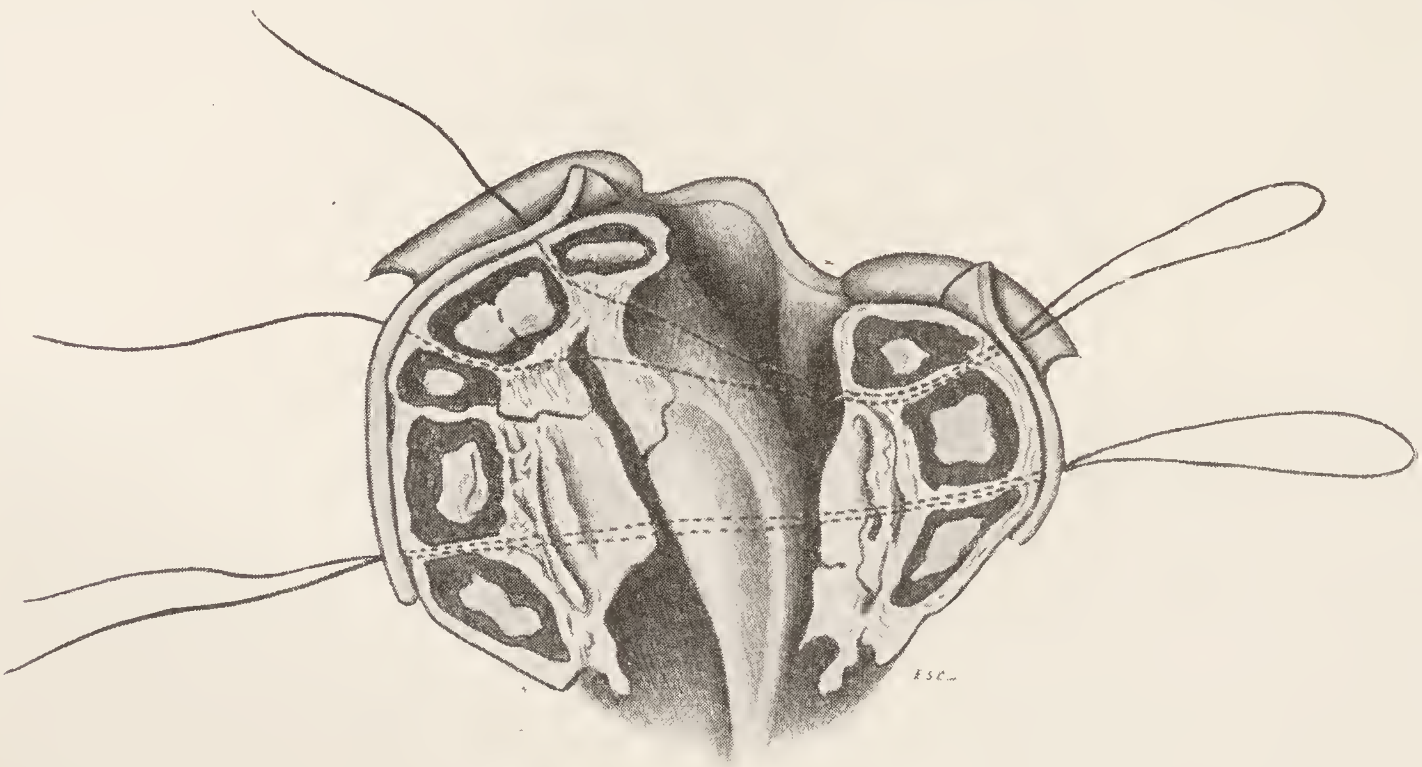


Fig. 457.—The extremely wide fissure is closed by passing the wire sutures between the teeth using lead plates to bring the edges of the cleft in contact. (*After Keith.*)

system of a child is not so well developed in early infancy as it is later. Therefore, young children usually react better, and this is one of the advantages of performing this operation before the nervous system has developed to a point which would subject the child to a more severe shock. Moreover, mental apprehension is eliminated and we all know that alarm and dread are among the most powerful factors in producing shock (see page 609).
5. The operation in early infancy brings into action the muscles of the palate. These, therefore, develop instead of becoming atrophied for want of use. Hence a good velum is secured, with plenty of tissue, whereas, if the operation is delayed until later in life, the muscles cannot as surely be made to subserve the same purpose as tissues which develop through natural employment. It is well known that muscular tissue is more perfectly

developed through action. The muscles of a cleft palate are not normally employed. By operating at a very early age, the muscles are at once brought into use and their development is proportional to other tissues.

6. Following early operation, there is much less deformity, for all the tissues, bony as well as soft, are brought into normal relations and develop naturally and according to accepted types. When the operation is postponed a few years, it is very difficult to secure such results.
7. When the palatal processes of the maxillæ are united, it will be observed that the development of the bones and the alveolar processes of the maxillæ assume a form nearly or quite normal and when the teeth are erupted they will occlude properly with the lower ones.
8. *The most important reason for making the early operation is that when made*

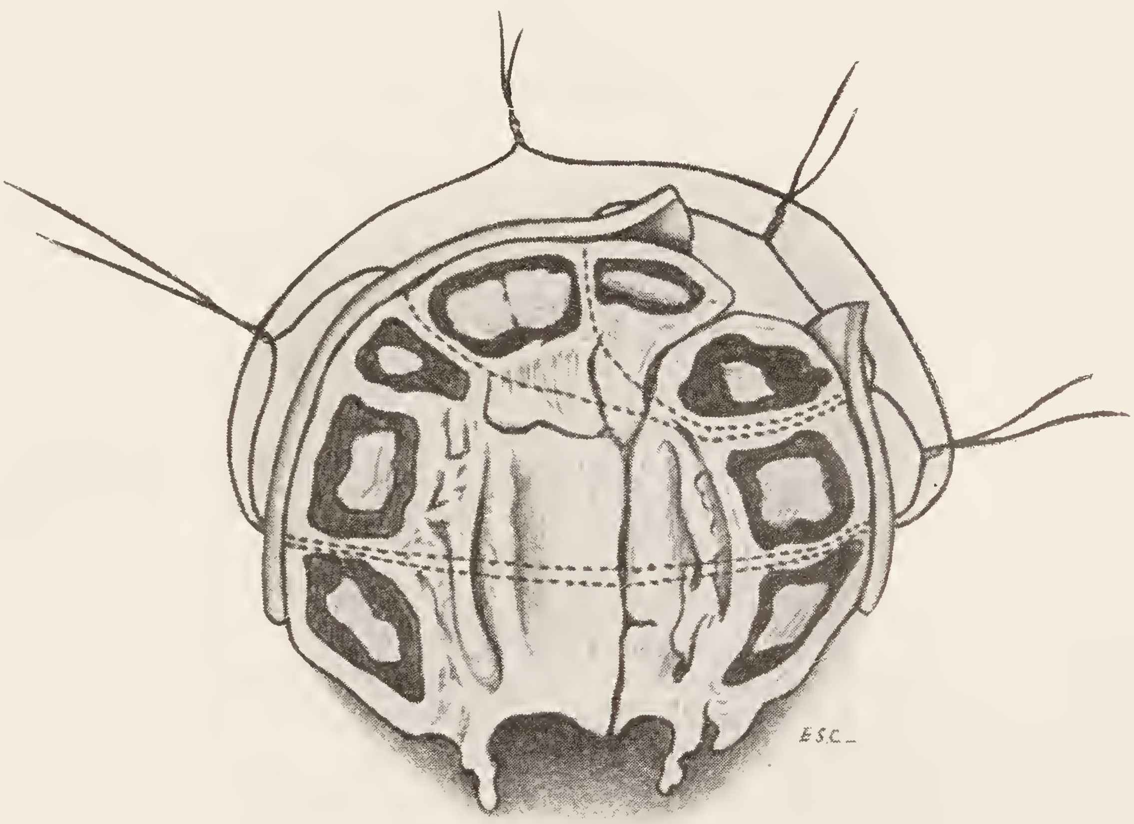


Fig. 458.—Fissure closed. Normality established. The bones have been bent into correct position. (*After Keith.*)

in early infancy, first, on the cleft hard palate, second, on the lip, and, third, on the soft palate, a normal condition is established which enables the patient to speak as children do who were born without this congenital defect.

In all patients there are irregularities of the incisor teeth joining the cleft alveolar process. This condition exists whether the individual is operated or not (Fig. 459).

It was predicted that, as the result of my operation, the upper jaw would be contracted and be made much narrower than the lower one, and that it must always remain contracted; also, when the teeth in the upper jaw were erupted, they would be considerably within the arch of the lower one. My answer was that later a skilled dentist would be able, by orthodontial methods, to spread the arch and correct the irregularities. I must confess

that I was operating for five years before I was impressed with what had proven a fact, that a cleft palate is a spreading of the upper jaw and velum and is not due to arrested development nor to an incomplete development of tissue which enters into its structure. Like many practitioners, I was willing to accept the teachings of authors without venturing to investigate and endeavor to solve the problem, which, through the centuries, had been misunderstood and erroneously taught.

Before discovering that the deformity consisted in failure of union and spreading of the arch, I worked without being able to state, from an anatomical point of view, why I moved those separated parts together.

Fig. 459.—The incisor teeth are always irregular in complete cleft palate whether operated or not.

Surgeons of good repute, clinging to the old theory and, in some instances, to the teaching of their own books, declared that my operation was inexpedient and without precedent; that it would cause nasal stenosis and, by abnormally contracting the jaw, produce a worse deformity than the one I was attempting to overcome. It is now recognized and admitted by surgeons familiar with my technic and results that my operation, more than any other, *establishes the normal anatomical condition.*

In a personal communication from Dr. Vilray Papin Blair of St. Louis, he states: "It seems to me that the matter under discussion resolves itself simply to this: a nasal obstruction certainly is a great detriment, especially

to a very young infant or animal, but, in approximating the jaws in cleft palate, there is no necessity of causing an obstruction. This can readily be proved by the illustration in my book showing the extent of the spreading of jaws in cleft palate (Fig. 391). Further, I do not see how one may well take the position that it is improper to approximate these spread jaws in an infant by your operation and yet be advisable to approximate them at the age of two years by orthodontic apparatus. The procedures are essentially the same and it is just a question whether you will do it at two weeks or two years."

In the teachings and operations of Sir Arbuthnot Lane of London, whose methods are hereinafter described, I find support in the position I have taken (that cleft palate operations should be made in early infancy). Lane thor-

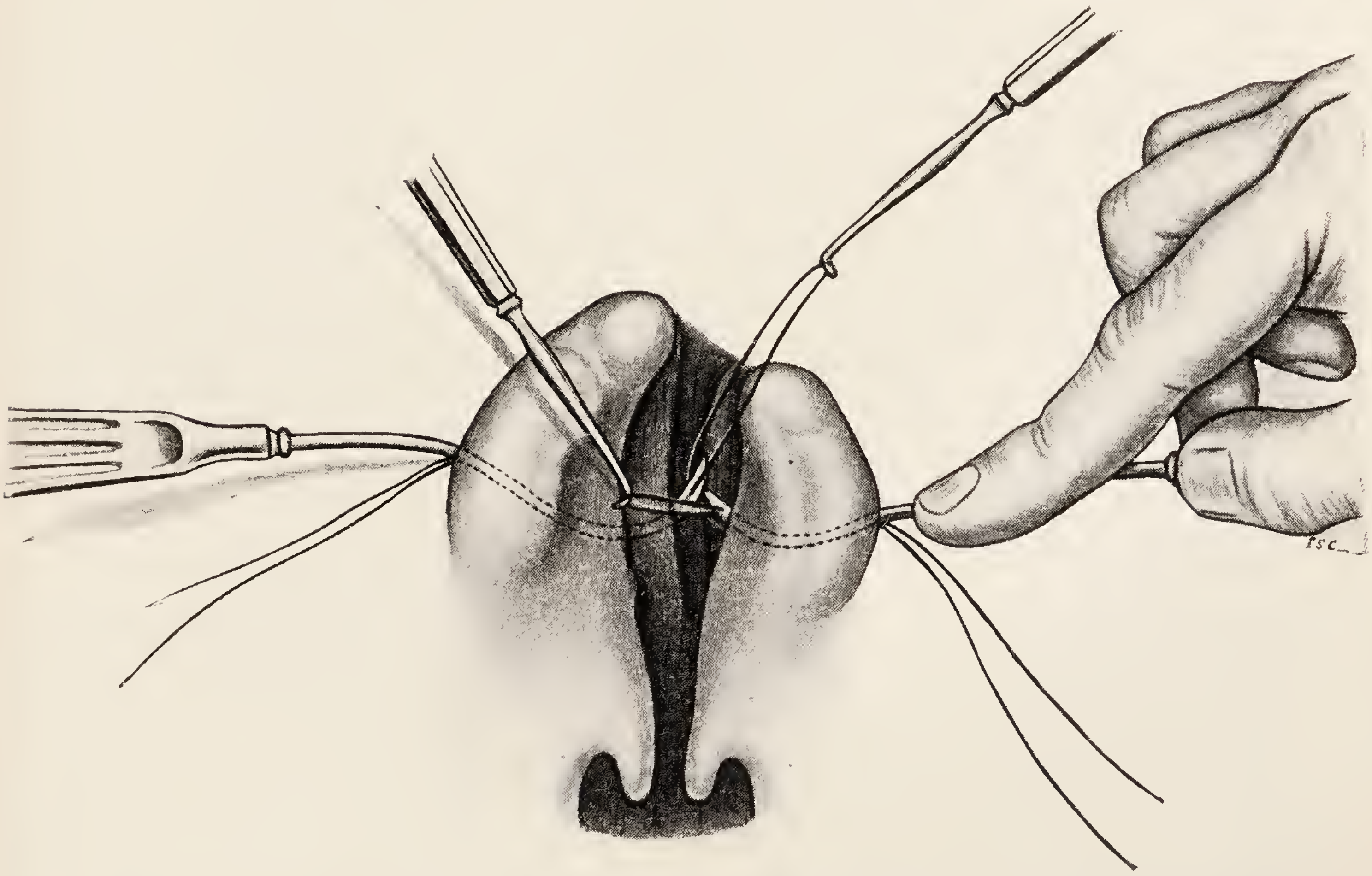


Fig. 460.—Method of introducing the pilot sutures in hard palate operations.

oughly described his operation in 1902.[1] His work has extended over a period of many years and his studies of the abnormalities of the palate and their sequelæ form one of the most valuable contributions to the literature of the subject. The anatomy and physiology of the parts in question have been dwelt upon at great length. The muscles associated with a congenital defect adapt themselves to the abnormal condition. This is observed in the muscles of the pharynx in cleft palate patients. These muscles are much larger, thicker and stronger than in persons whose palates are normal (Fig. 578).

Lane has pointed out and agreed with me in this, that persons thus afflicted, though otherwise normal, do not usually develop as vigorously as

[1] London Lancet, February, 1902.

those free from the defect. A cleft palate patient, as a rule suffers from chronic pharyngitis, hypertrophied tonsils and adenoid growths.

My method of procedure in operating for closure of complete cleft palate in children under six months of age is as follows: The patient should be prepared as previously described. No speculum or gag is necessary in this operation since the patient is without teeth and the mouth is easily held open by the fingers. After the babe is anesthetized, we are ready to proceed with our operation. For convenience in description, we will continue to use the method employed in the previous chapter.

Form 7.—*Complete single cleft of the entire soft and hard palates. The maxillary bone is separated from the premaxillary bone; harelip may be partial or complete.*

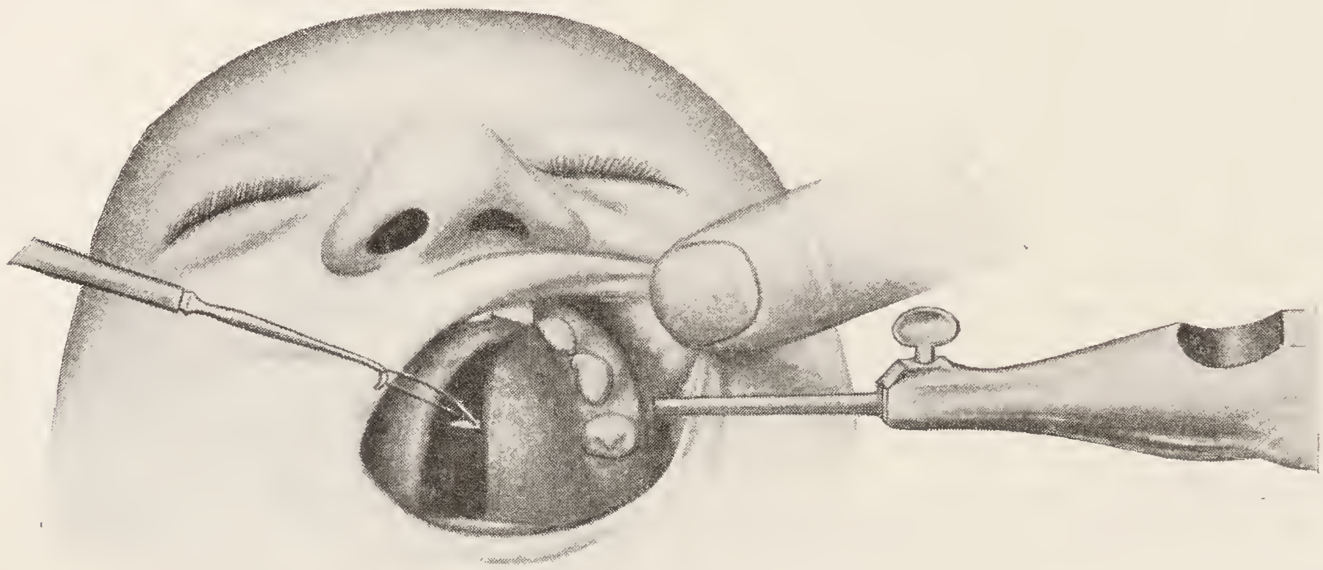


FIG. 460*a*.—Straight needle carrying pilot suture into the cleft. The tenaculum disengages the sutures. A loop is carried through the opposite side of the jaw in the same manner.

After the patient is anesthetized, raise the right cheek high and insert a large strong needle with the eye in the point (Fig. 513), threaded with a heavy braided double silk suture, through the substance of the right maxillary bone at or just behind the malar process.[1] The needle should enter the tissues at the fold of the mucosa or a little above and should be carried over the hard palate to the center of the cleft, where its point will be seen (Fig. 460). The needle should be so introduced that the flat surface will pass between the teeth which are easily located by the touch of the point of the needle (Fig. 461). The suture is seized by the tenaculum and its end drawn

[1] During the past few months I have been using a very small straight needle. The bone is first penetrated by a small, straight, inflexible, steel drill as it can be more easily passed than the curved needle illustrated in Fig. 460. In the hands of the inexperienced, the straight instrument is safer as the operator can easily pass it between the teeth without disturbing them. He must, however, be able to detect a tooth when the instrument comes in contact with it and also to change the course of the drill, so that he passes it between the teeth. Immediatly after withdrawing the drill, a similarly shaped steel needle with the eye in the point is carried through the hole made by the drill. The needle carries the pilot suture, which is removed as shown in Fig. 461.

out of the mouth while the needle is also removed. We have now a double suture through the right maxilla with the loop end in the center of the cleft. With the opposite needle, carry a corresponding suture through the left bone. We then have two silk suture loops carried through the bones to the center of the cleft, and, by passing the left loop through the right and making traction on the latter, we carry the left loop through both maxillary bones (Fig. 462). Nearer the front portion of the right maxilla, insert another double

FIG. 461.—Dissection of upper and lower jaws, exposing the unerupted teeth. The photograph of this cadaver shows the external alveolar plate removed. The position of the teeth and the ease with which a well directed needle may be carried between them so as not to disturb them, may be noted. In passing the needle it should be so used that the flat side will slip in between the teeth. In penetrating the tissues, the expert hand will easily detect the difference between tooth and bone. When the needle comes in contact with the tooth it should be directed first forward and then backward until it slides between the teeth and passes through the tissues. (*Special dissection by Dr. H. E. Radasch.*)

suture with which to carry the second loop to be inserted in a corresponding position in the left maxilla. The left loop is carried by means of the right loop through the right bone (Fig. 463). We now have two loops extending through both bones and with these we carry the double silver wires into place.

Still nearer the anterior part of the right maxilla, the long part, we insert another pilot suture. The needle should pass between the positions to be

occupied by the right central and lateral incisor teeth. One of the double anterior wires, which passes through the bone, is drawn back to the center

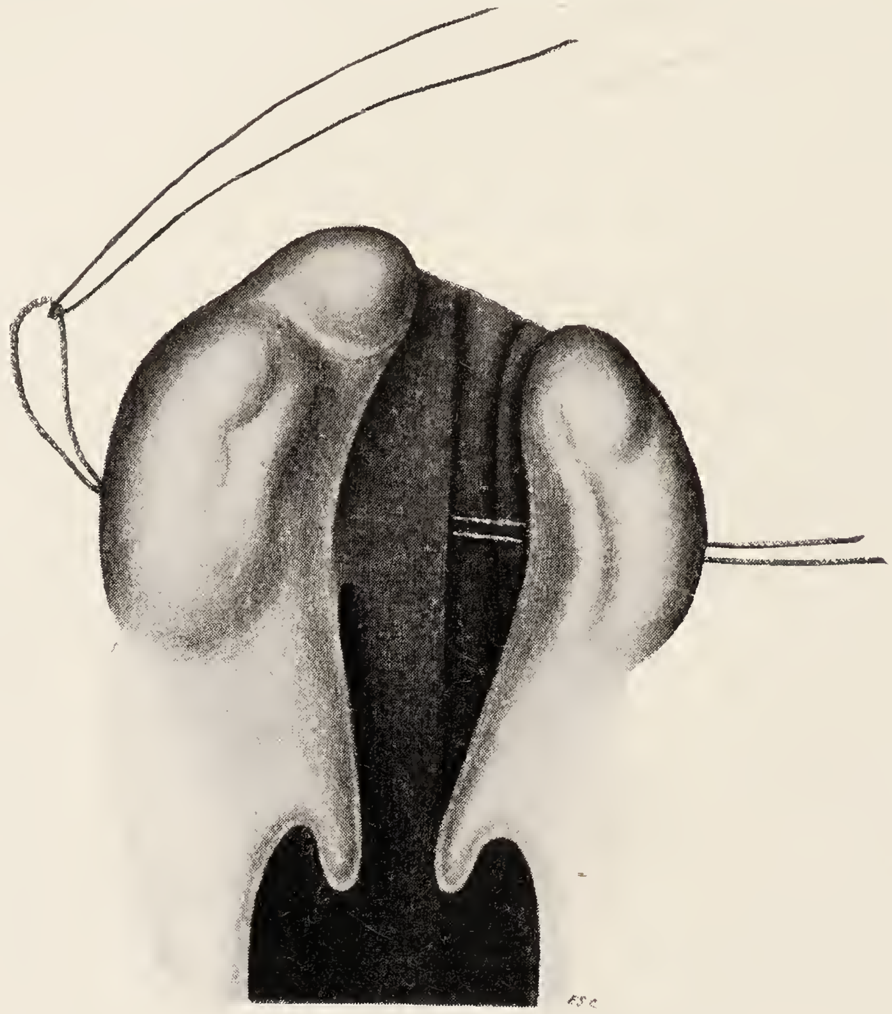


FIG. 462.—Pilot suture of silk has been introduced and silver wire is shown passed through the loop in the pilot suture. By pulling on the silk, the silver wire is drawn into place. After this the loop in the silver wire is cut, thus giving two sutures.

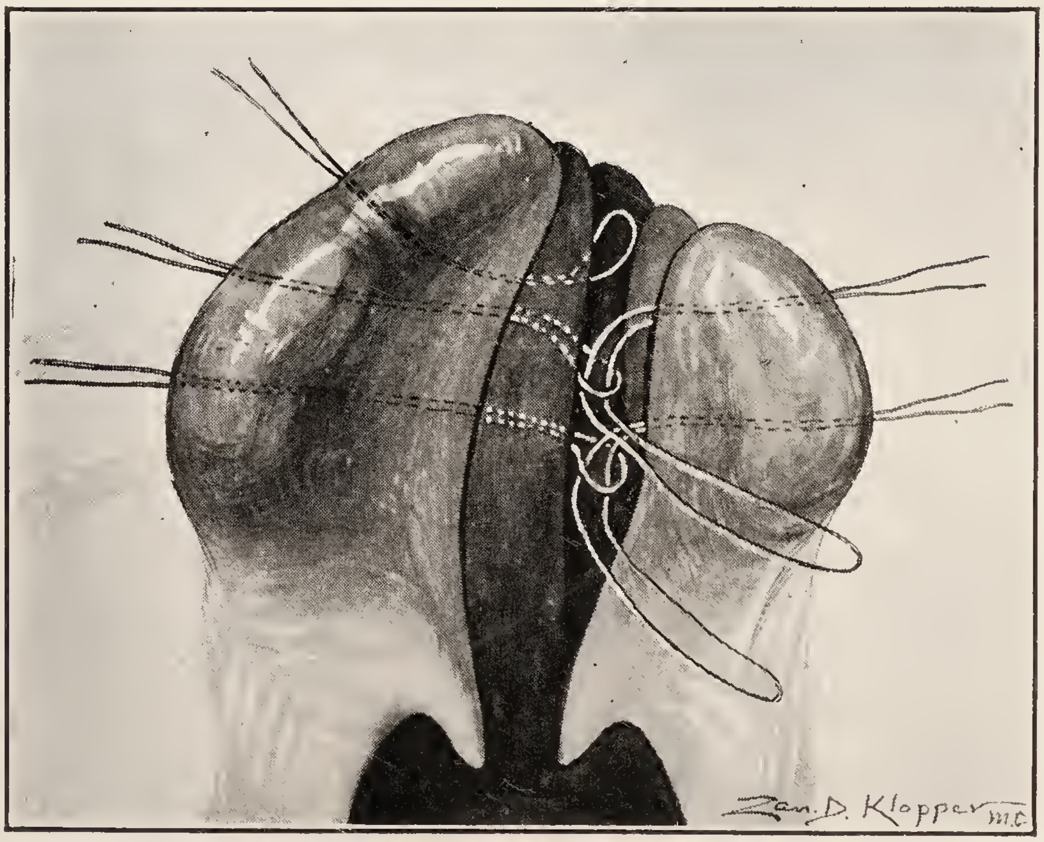


FIG. 463.—Pilot sutures all inserted.

and out of the right bone. This wire is fixed to the anterior loop last inserted and drawn through the bone (Fig. 464). The double strands of No. 20 gauge

wire are now passed through the maxillary bones above the hard palate. They are then separated, making four single strands (Fig. 465). These wires are larger than those used in the soft palate as they must be stronger.

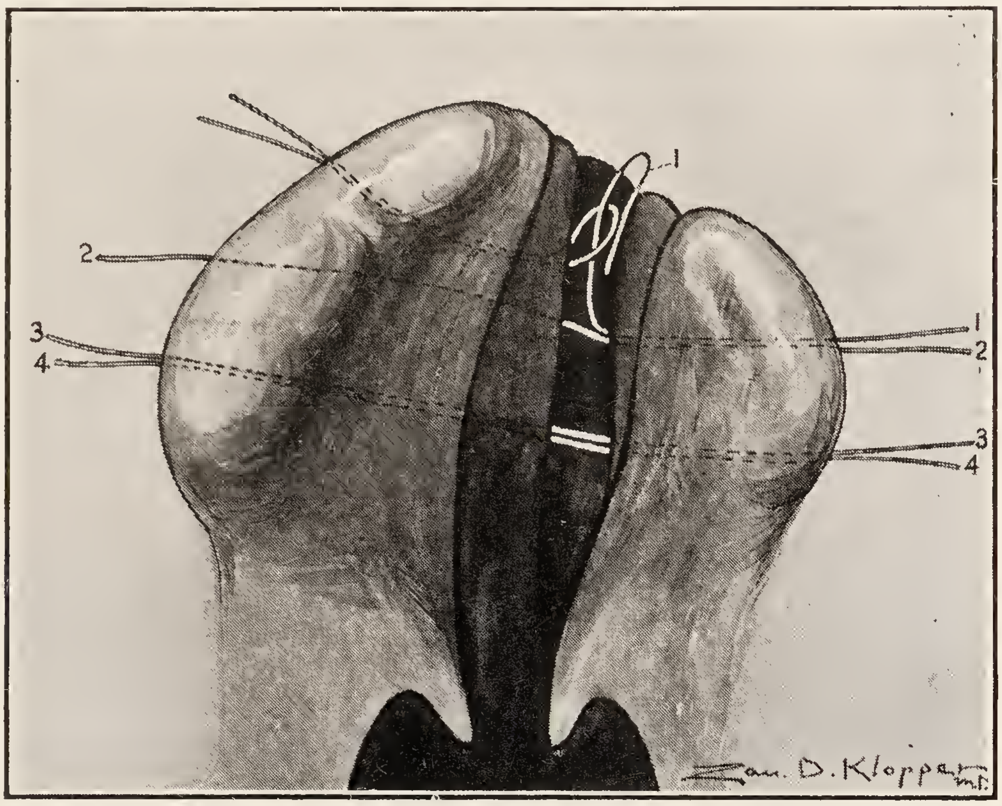


FIG. 464.—One of the anterior double wires (1) withdrawn from the long side of the bone and passed through the loop of the anterior pilot suture.

The next step is to make lead plates—No. 17 American gauge to fit the convexity of the buccal surfaces of the bones. These should be smooth,

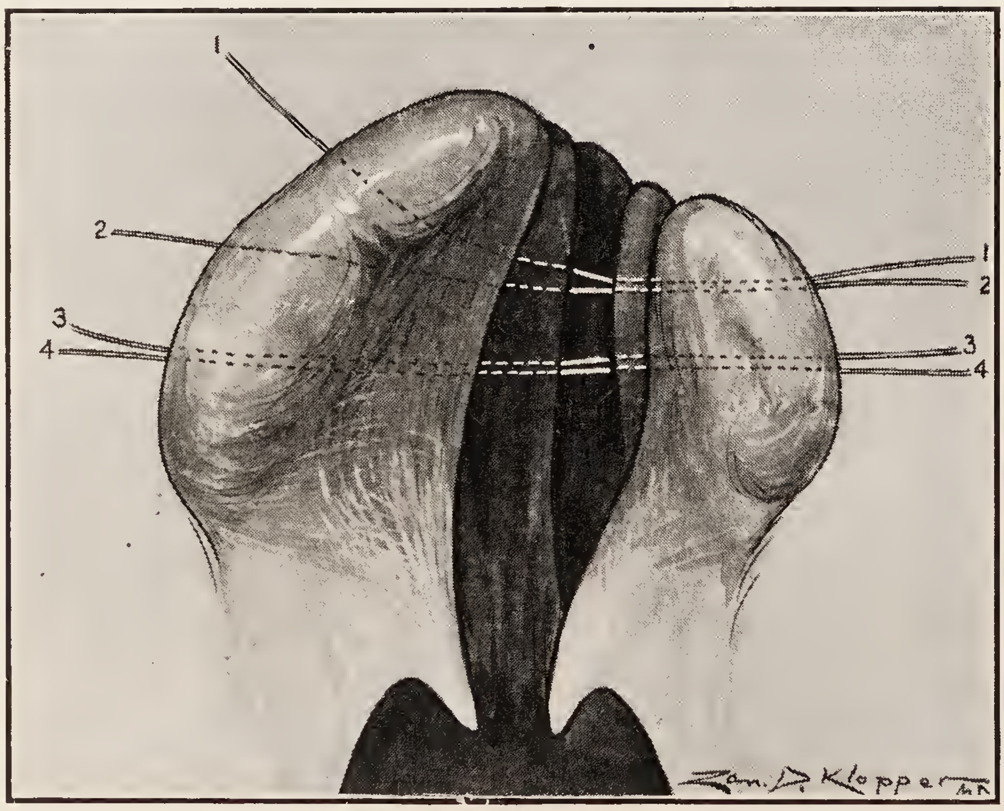


FIG. 465.—Silver wires in place.

the sharp corners removed and they should be perforated with holes corresponding to the position and number of wires. The right side of the lead plate will have two wires in the posterior hole, one in the middle hole and one

in the anterior. The left plate has two wires in each hole (Fig. 466). One of the posterior wires (3) on the right side should be twisted with the middle wire (2) on the same side, care being taken to keep the *twist* as near the center of the distance between the two holes in the plate as possible. The operator must use care in twisting the same wires on the left side as he twisted on the right. Having these wires twisted up close to the plates, he then seizes the twist with a pair of forceps, draws the slack out, and, while making pressure on the plates toward the bone, he twists the wires first on the right, then on the left side. Moving the bones together, by twisting the wires against them, should not be attempted as the force may break the wires. An instrument should be placed against the lead plate and crowded toward the bone while the wire is being pulled and twisted. By so proceeding, the danger of breaking the wire will be avoided.

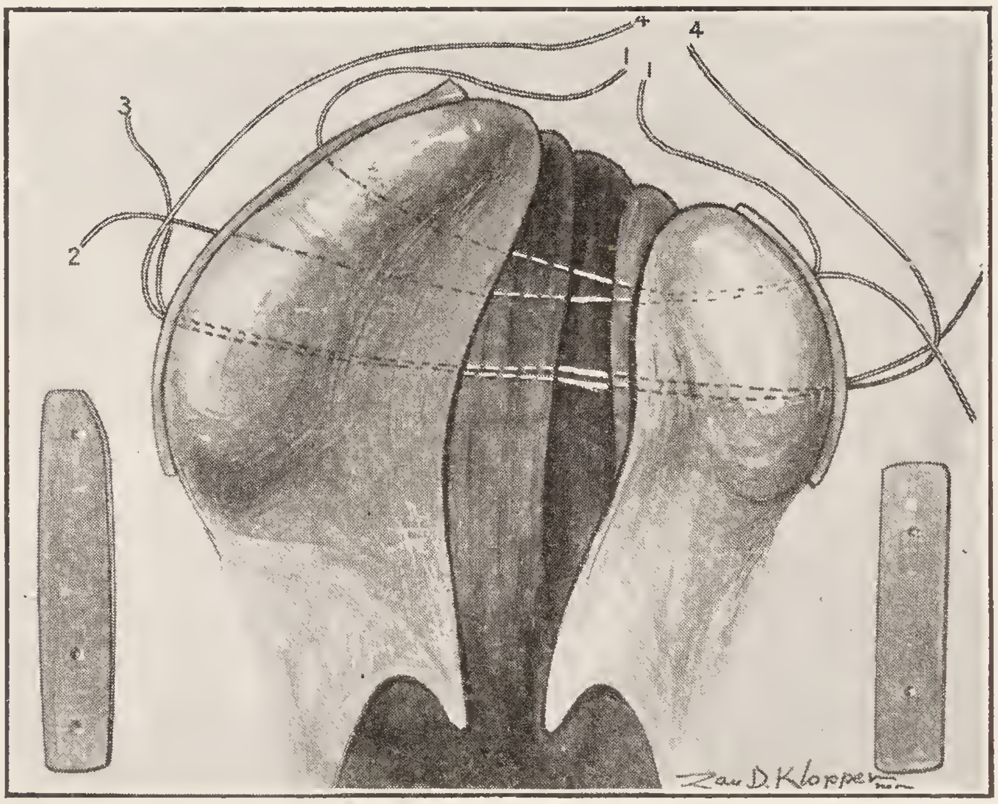


FIG. 466.—Wires and plates in position. The method of fastening the wires is shown by numbering each end. Right and left lead plates are shown.

In the September, 1912, number of Items of Interest appears an article from Dr. Bernard Shea of Brooklyn, in which he describes a device for the moving together of the separated bones.

The device which Dr. Shea has presented is ingenious and will operate in certain cases. I used practically the same thing twenty years ago, using, instead of nuts on the sides, little pieces of lead which I passed in between the wires and plates, thus making greater pressure, but, after using it a year or two, I abandoned it since I could accomplish the same results by bringing about immediate union.

It will be remembered that two wires remain through the bones which have not been used (1 and 4). We now take the anterior wire (1), carry it under the lip through the frænum and twist the ends together just in front of the cleft alveolar process and between the borders of the harelip. The

thumb should then be placed on the long prominence of the right maxillary bone, really on the premaxillary bones, pressure made and the cleft bones moved into proximity. The posterior wire (4), not yet employed, should be carried forward and the ends twisted together to serve as a re-inforcement to the anterior wire (Fig. 467). When the cleft is nearly closed, scarifying instruments (Fig. 515) should be used to freshen the edges and prepare them to unite.

Fig. 468 shows a sagittal section of the head with the wire sutures inserted and lead plates on the buccal surfaces of the bones. Fig. 469 shows the cleft closed and the parts approximated. I wish to emphasize the fact that the wires pass above the hard palate and not beneath it, as has been so frequently illustrated by those unfamiliar with my work. If the wires are passed below the hard palate, the alveolar processes will be drawn toward

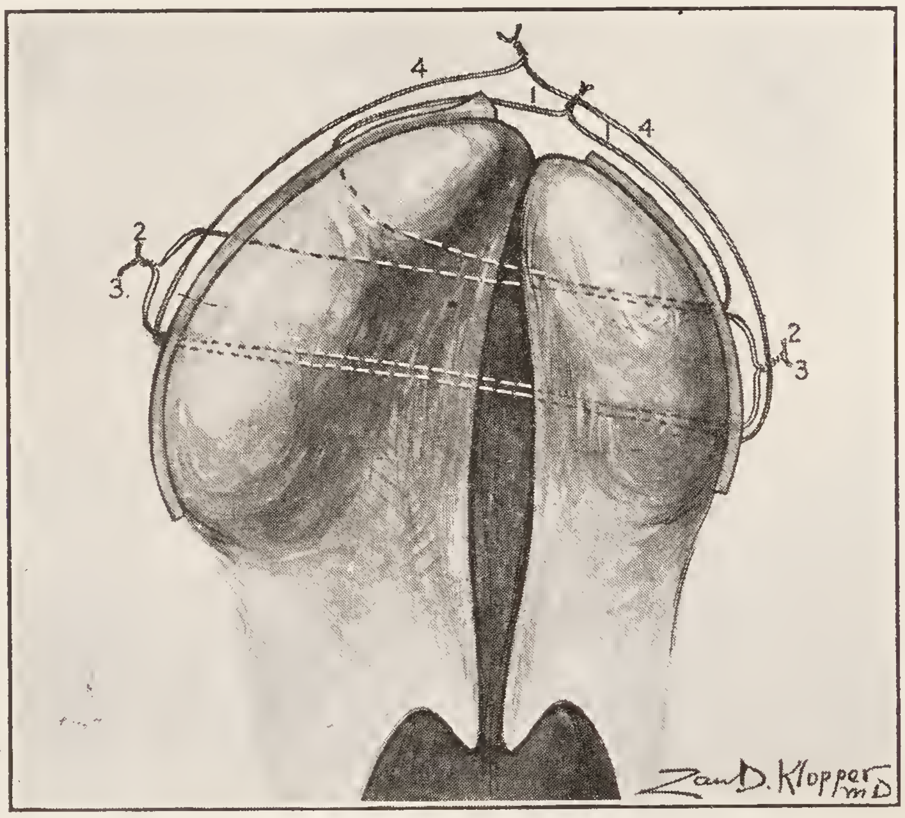


Fig. 467.—Twisting of the wires completed.

the center and the hard palate tilted upward, thus defeating the object of the operation. These figures clearly illustrate the efficiency of the method of moving the separated bones together without fracture or 'crushing,' and the bringing of the maxillæ into normal relation with the mandible, thus removing the deformity.

After the wires are inserted, and just before the edges of the bone are brought into contact, a small knife should be passed about one-quarter of an inch posterior to the border of the maxilla on either side of the cleft, making flaps long enough and thick enough, when sutured, to prevent leaving a notch in the bone and to secure a normal bony arch (Fig. 484). Moreover, the muco-periosteum on each side of the anterior portion of the cleft—from the nasal cavity to the lower border—should be elevated, approximated and sutured, thus preventing the depression and closing the opening between

the mouth and the nose, which, too often, is to be observed following cleft palate operation.

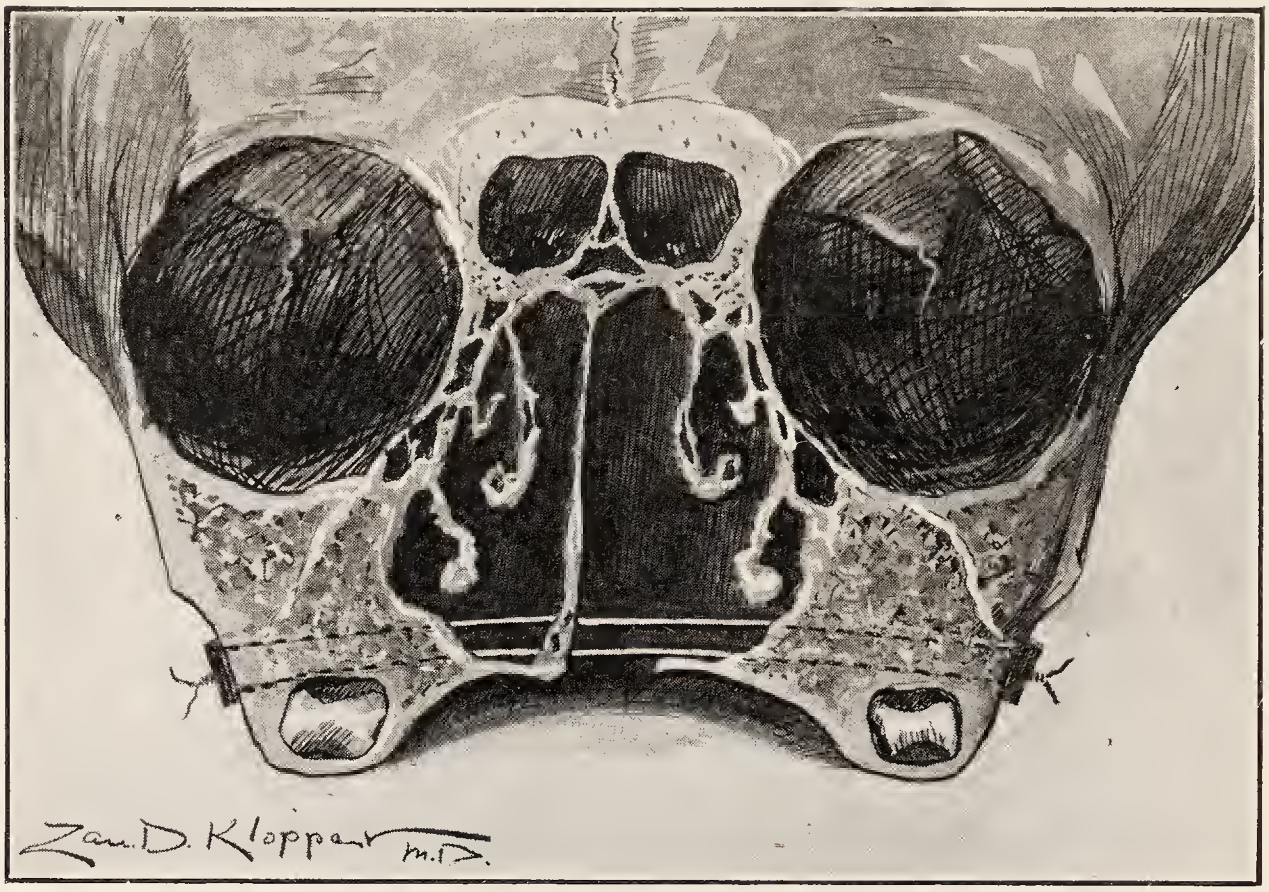


FIG. 468.—Sagittal section of the bones of the face showing cleft of the hard palate with silver sutures and lead plates adjusted.

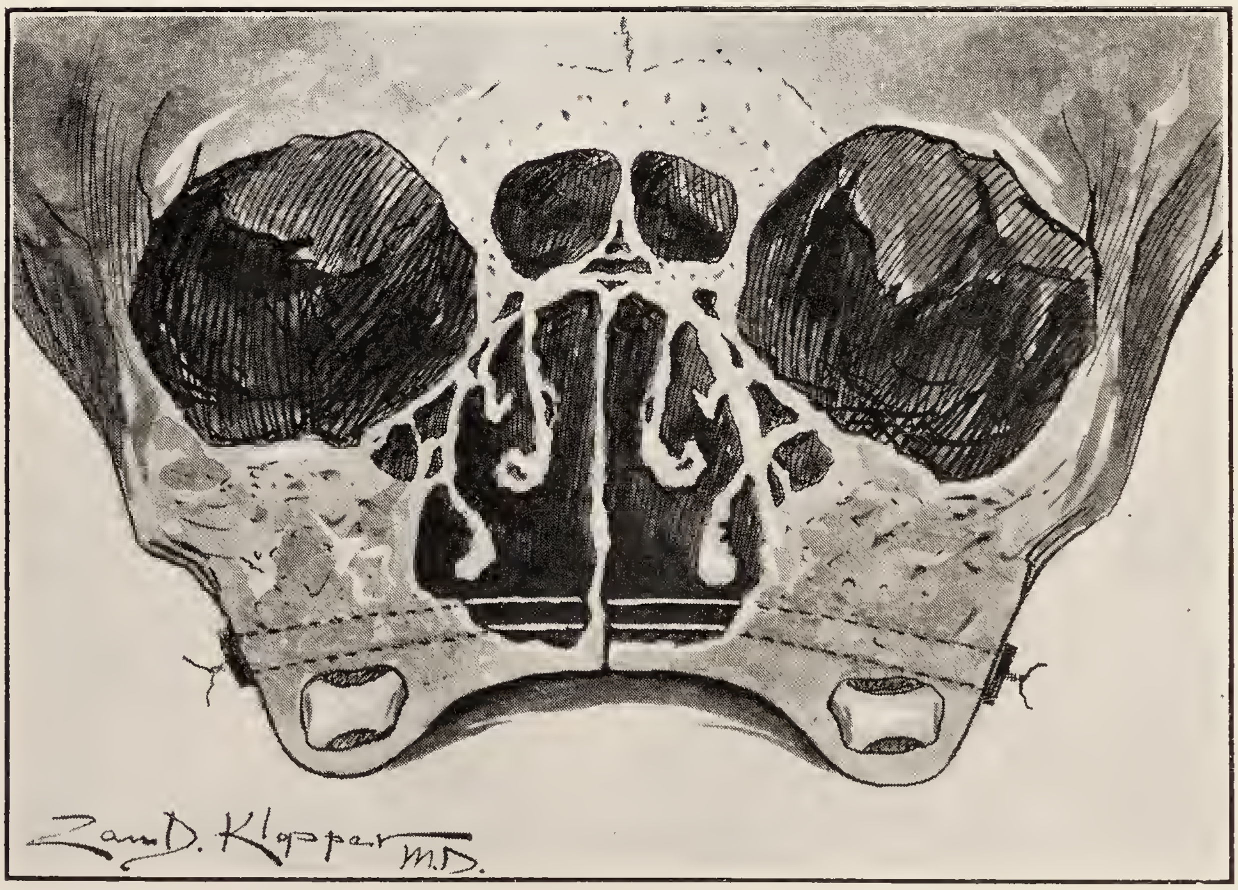


FIG. 469.—Vertical section of skull showing wire sutures in place. Edges of cleft are approximated.

Having freshened the edges and made the anterior flaps, we make pressure again with an instrument on the lead plates, twist the wires and bring the edges of the cleft into close proximity. In my earlier work, if the edges of

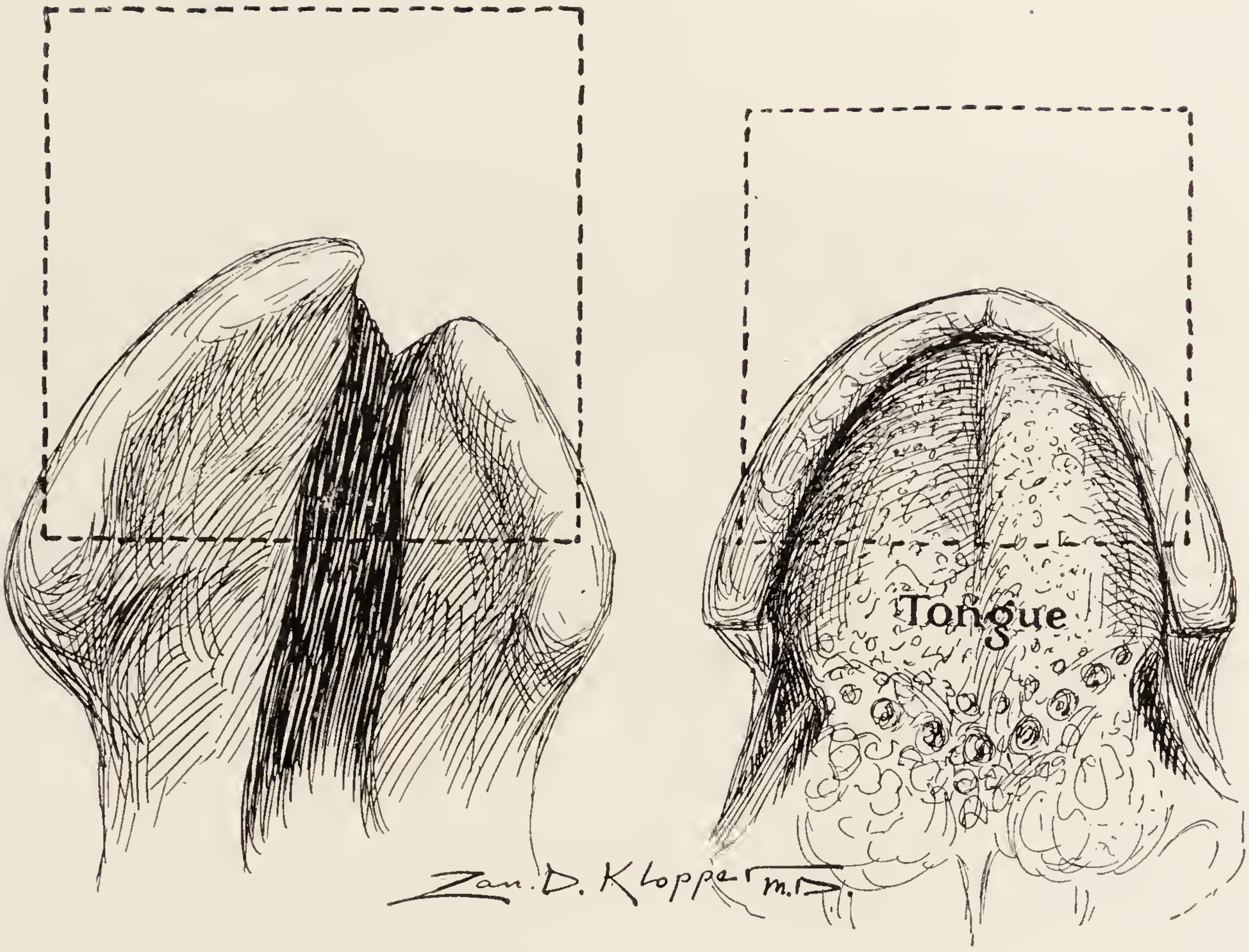


Fig. 470.—Before operation.

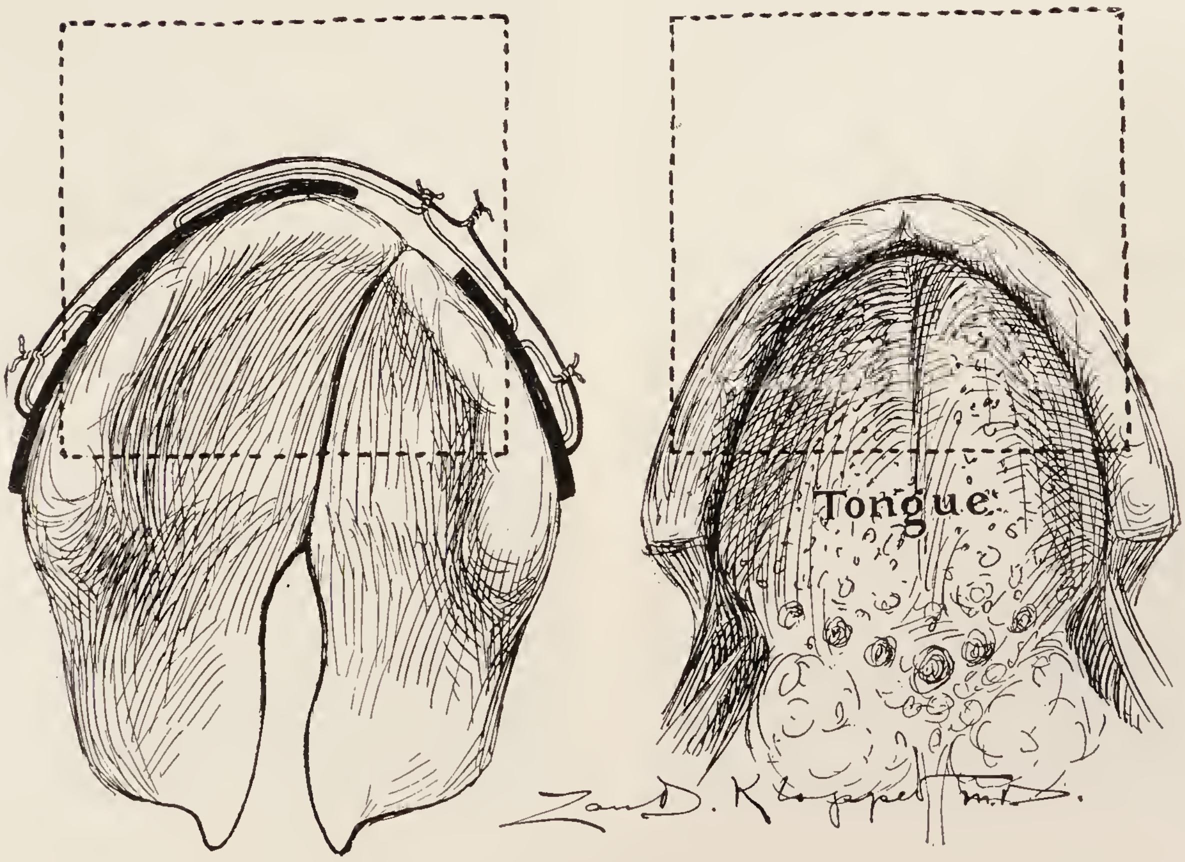
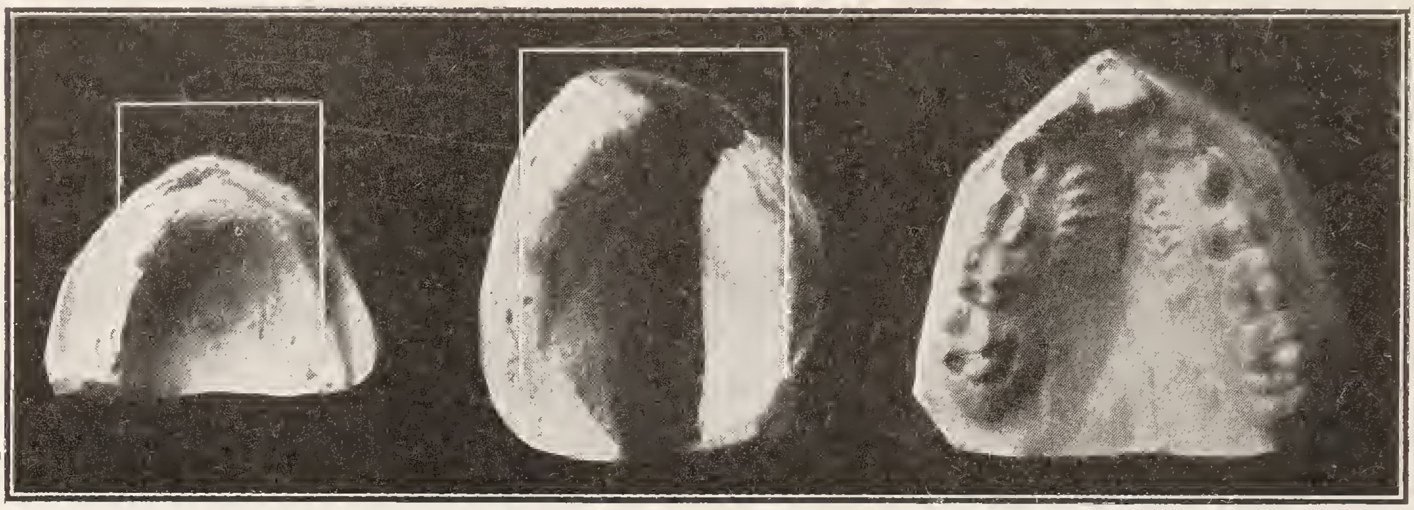


Fig. 471.—After operation.

Drawings from careful measurements of casts from life, showing relative positions of upper and lower jaws in the case of cleft palate in a young child. (The print is life size.) The dotted squares are made in exact proportion to the width of the respective alveolar processes at corresponding points. The large square is the width of the cleft greater than the smaller square. When the cleft is closed the squares will be of equal size, and consequently the teeth will occlude normally.

the cleft did not meet, I divided the mucous membrane and the bone through the malar process on both sides so the bone could be moved toward the median line. Many years ago I abandoned this step, as I found it unnecessary.



A *B* *C*

FIG. 472.—*A*, Plaster cast of mandible; *B*, plaster cast of widely separated cleft palate in an infant four weeks old. The squares made above indicate the difference in the breadth of the two jaws. The upper is as much wider than it should be as the distance between the borders of the cleft. *C*, Condition of the same palate at the age of seven years. The permanent first molars and central incisors are normal and in place. All the deciduous molars are also in place. The boy has a well-formed dental arch and a good palate. Unfortunately the plaster cast was cut too short so that the entire soft palate is not represented.

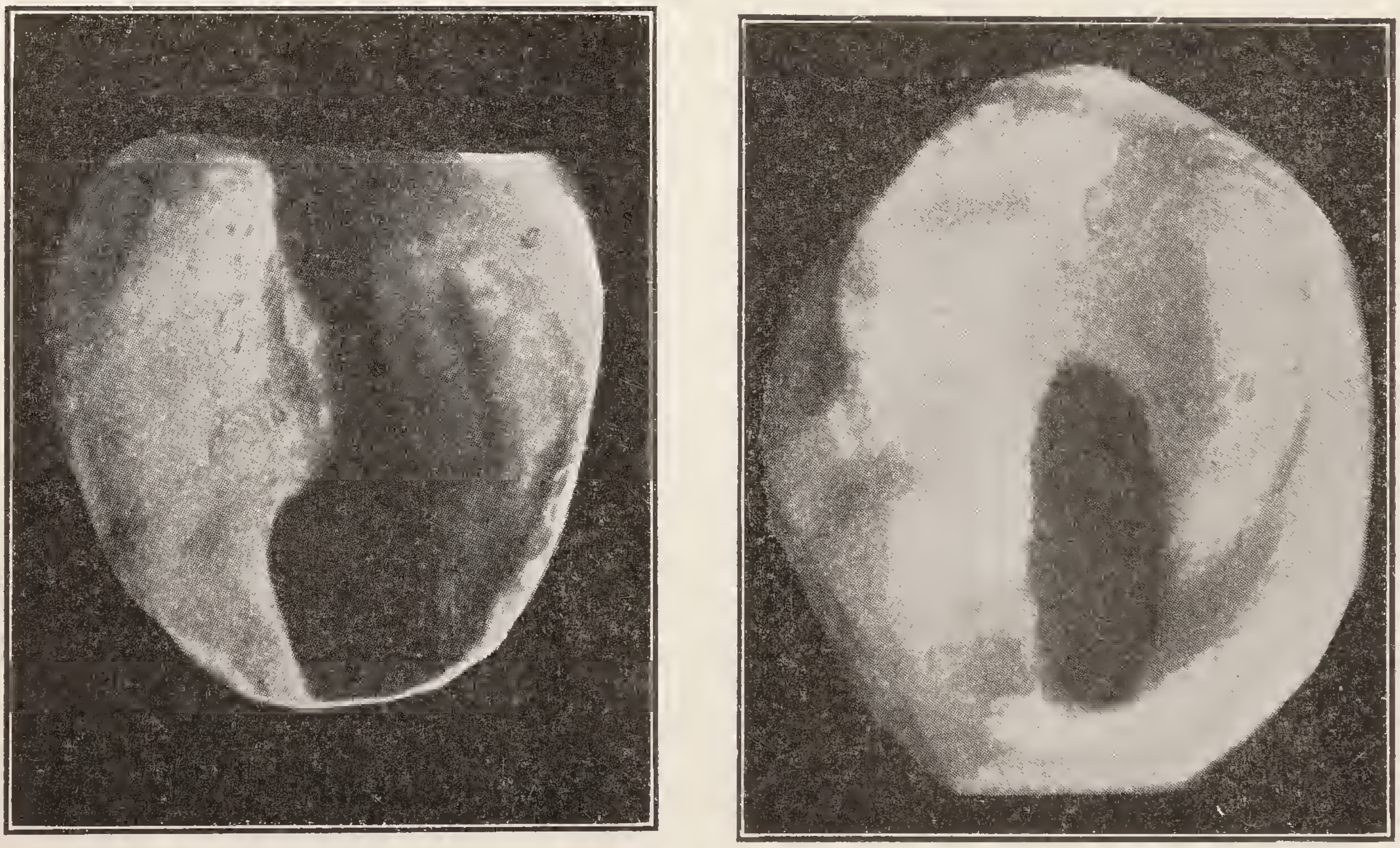


FIG. 473.—Plaster casts of Form 7 cleft palate before and after operation. The child in this case was six months old. The central incisor teeth had partially erupted. In this case the bones were still flexible which made an operation possible at this time. The soft palate was closed later. A good result was secured.

This operation is attended by only slight hemorrhage. What little hemorrhage occurs is caused by the insertion of the needles and the scarifying of the edges of the cleft. This is promptly arrested by quickly pressing the

freshened parts in contact. If need be, a solution of 1–10,000 adrenalin chloride may be used. This, however, is rarely needed. I have found that

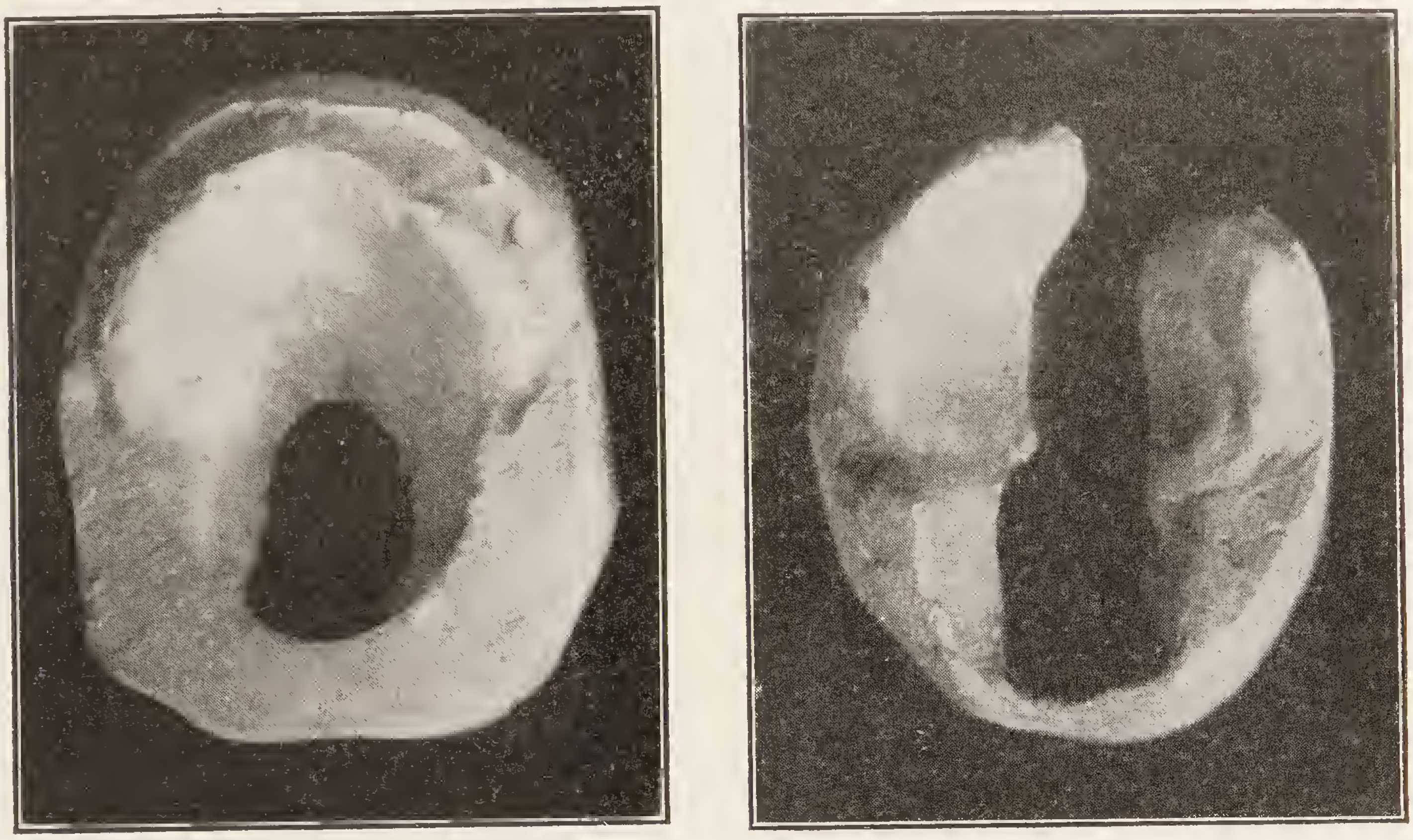


FIG. 474.—Plaster cast of Form 7. Cleft palate before and after approximating the bones. The cast of the closed bones was made four months after the operation.

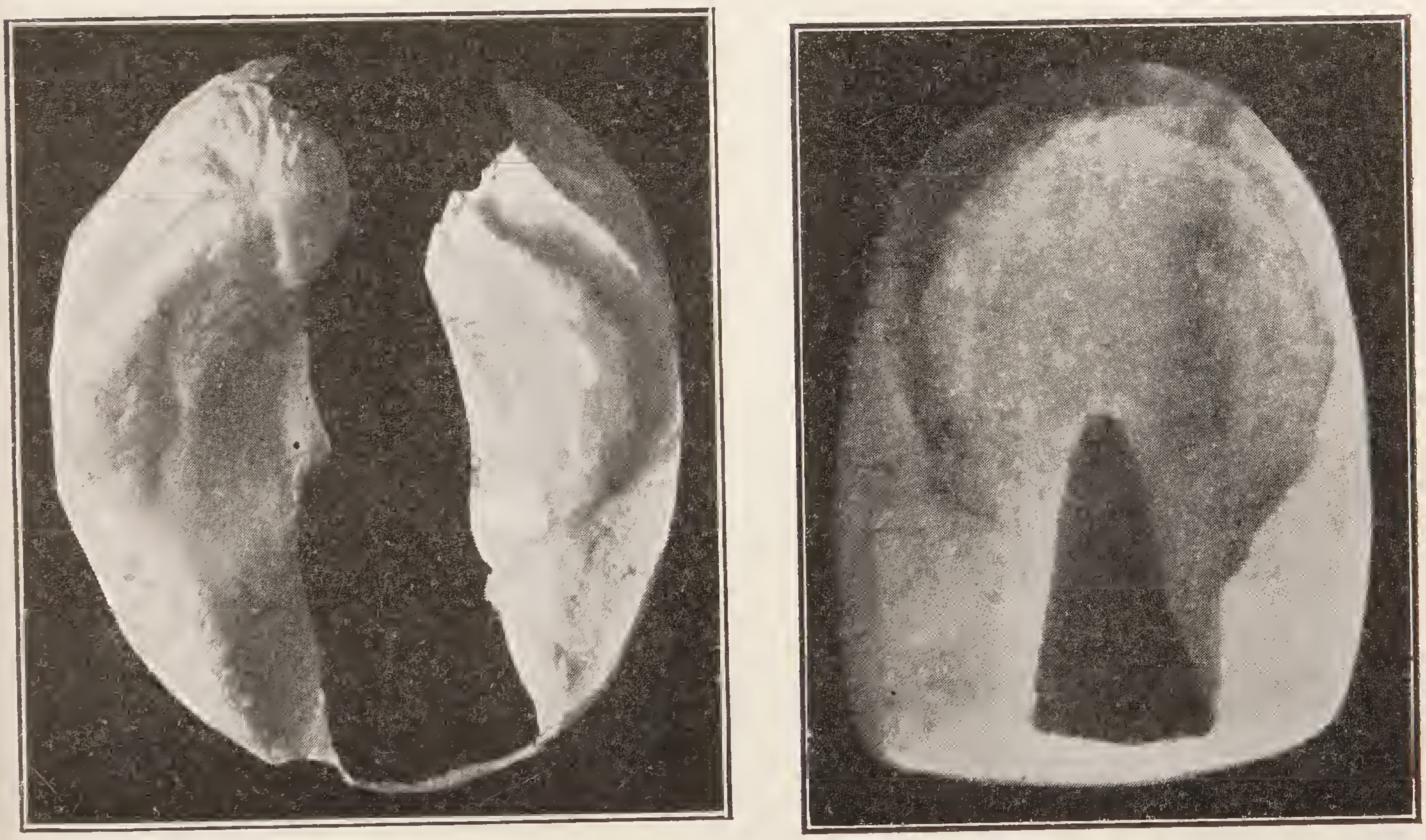


FIG. 475.—Plaster cast of Form 7. Cleft before and after approximating the bones. Flaps of the tissues in the anterior part were made in order to avoid a notch. The cast of the closed bones was made five months after the operation.

the reaction following adrenalin chloride is considerable. For that reason I regard its use as objectionable. Figs. 470 to 472 show the relation of the upper to the lower jaw before and after operation.

Form 8.—*Tripartite cleft, extending through the soft and hard palate, the premaxillary bones separated from the maxillary bones* (Fig. 420).

FIG. 476.—A study of the growth of the palate from infant to adolescence. The cross on both palates is the same size, 18 mm. in length and 20 mm. in width, which are the full dimensions of the infantile palate. The measurements on the infantile palate were taken from the anterior palatine canal to the posterior nasal spine, and between the posterior palatine canal. When the cross of the same dimensions is laid on the adult palate, taking the anterior palatine canal as the fixed point, it will be seen that the cross piece is at the level of the posterior borders of the second bicuspids, which is the original position of the posterior palatine canals, and while there is a slight lateral and forward growth of the palate, the great part has been backward which was to be expected because it corresponds to the direction of growth of the alveoli of the upper and lower jaws. (*Blair.*)

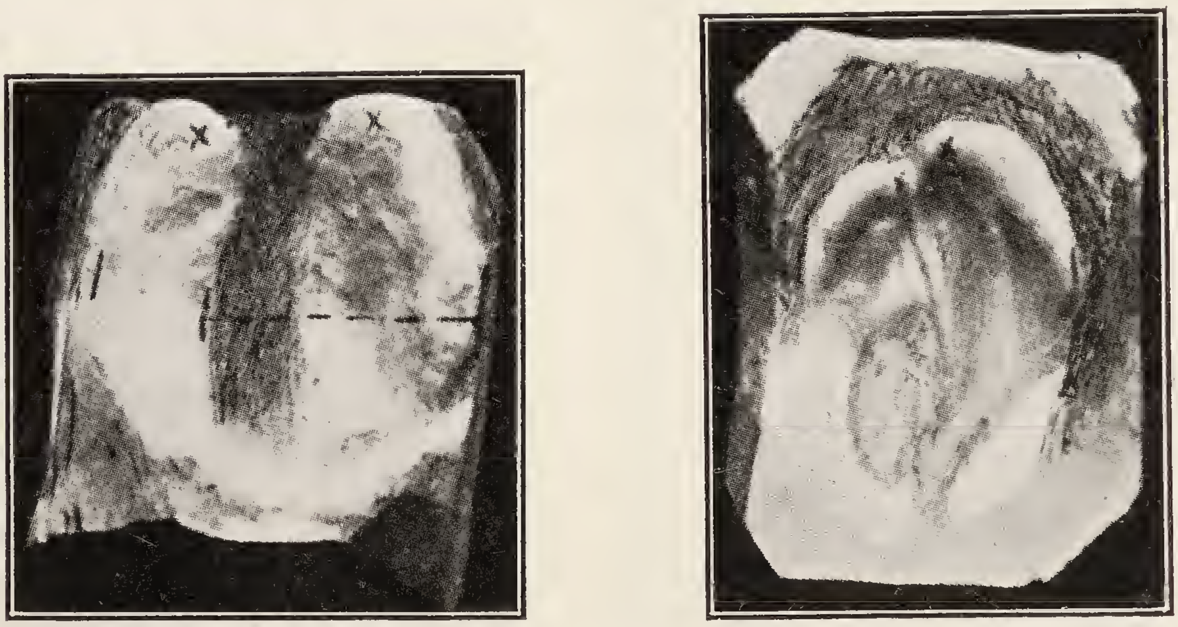


FIG. 477.—Casts of a case before and after the operation of approximating one maxilla with the maxilla and intermaxillary part on the other side of the cleft. The picture to the left presents the condition before operation, that to the right after operation. The dotted line across part of the first picture shows the width of the palate after operation and demonstrates that the palate was narrowed by nearly one-third of its greatest width. The apparent discrepancy in the size of the maxillary bones in the two pictures is due to the fact that in the position in which they are seen before operation a greater bulk of the jaws is turned broad side to the camera than appears after operation. The exact cross measurements on the casts are 36 mm. before operation as against 27 mm. after operation. (*Blair, in The Dental Era.*)

In this form of cleft, we find the maxillæ widely separated. Occasionally a band or bridge of tissue may connect the premaxillary with the maxillary bones on one side (Fig. 400). This band rarely connects both sides. The

premaxillary bones always contain the germs of the central and sometimes the lateral incisor teeth. The laterals are occasionally found to be imbedded in the substance of the maxillary bones proper; or, according to the teachings of Albrecht, there may be an intervening bone between the premaxillary and maxillary bones which may contain the germs of the lateral incisor teeth (Fig. 480).

Fig. 478.—A cleft of the palate with harelip on left side. The nose is diverted to the right.

Fig. 479.—Same patient with hard palate closed. Nose brought toward the median line.

This deformity, complicated with double harelip, is the most conspicuous and mentally distressing deformity known to mankind. On reviewing the literature at my command, I am convinced that the protruding premaxillary bones have never received the careful, serious consideration which has marked the investigation of surgeons in treating other physical defects. In some

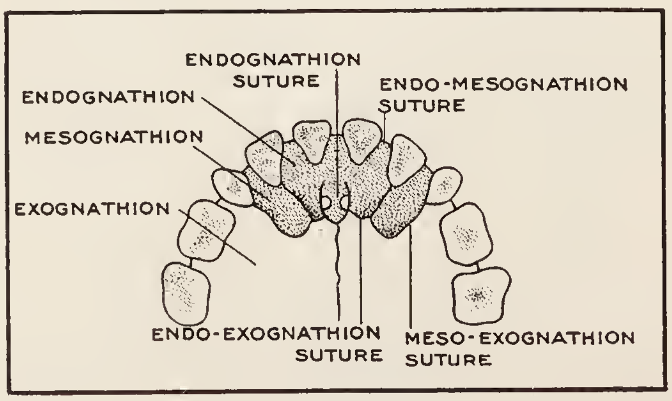


Fig. 480.—The premaxillary bone and its sutures. Shows six incisor teeth. (*Gray's Anatomy.*)

works the authors advise excising these bones, while others advocate closing the lip over them when possible. Still others advise removing a V-shaped piece from the vomer, moving the bones back and closing the lip over them. To excise the bones is to produce an irreparable deformity. To move them back in contact with the maxillary bones and close the lip over them is to leave them like an un-united fracture through life.

Protruding premaxillary bones should be considered in the light of a fracture and so treated. *Under no circumstances should they be removed.* These bones, together with the teeth which they embrace, have an important function. They add beauty and symmetry to the face. Their loss means prognathism with its unsightly deformity. The upper lip recedes and the nose becomes broad and flattened. Altogether the loss of these bones is always unnecessary, unsurgical and to be deplored.

I have stated that the premaxillary bones should never be excised, nor should they be forced back without securing bony union and the deformity concealed from view by closing the lip over them. Would a surgeon in the

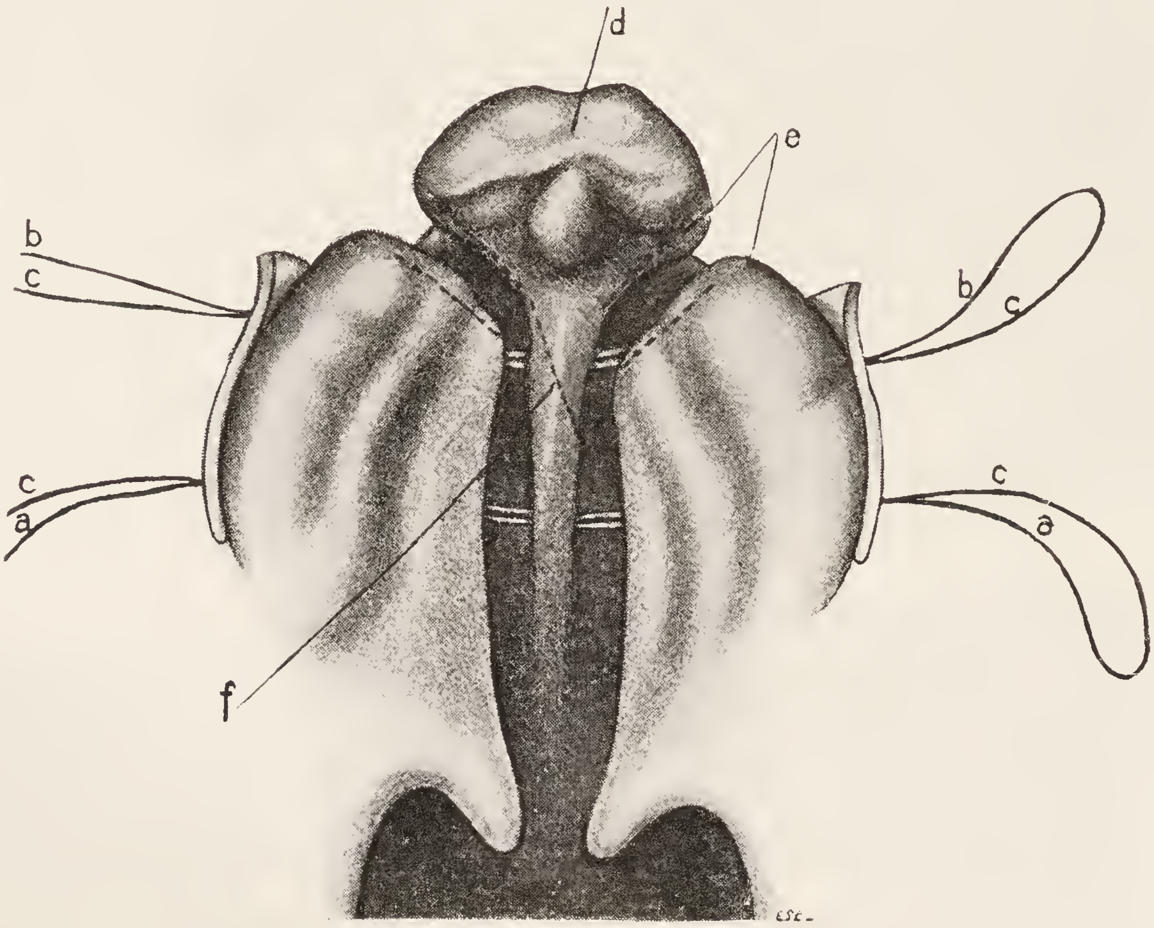


Fig. 481.—Method of treating tripartite cleft palate. The wires have been introduced and the lead plates adjusted. The dotted lines indicate the incisions. It will be noticed that the vomer is cut obliquely so as to allow it to be moved backward into proper position. The wires, etc., are lettered in order that they may be identified in the subsequent figures.

treatment of a compound fracture of the femur feel that his duty was well done if he crowded the fragments into place without removing intervening tissue and closed the external wound? Would he expect to secure bony union without the adjustment of splints and without immobilizing the parts? A normal maxillary arch can be secured by treating the parts in the same manner as one would an un-united fracture.

It is too apparent to require argument that these deformed bones should be united and a normal arch secured before closing the lip.

The surgeon's first duty in the treatment of this form of cleft is to bring the premaxillary bones in proper position and move the maxillary bones close in contact with them, thus bringing the abnormally broad arch to a proper breadth and establishing a solid, bony alveolar ridge. The surfaces of the

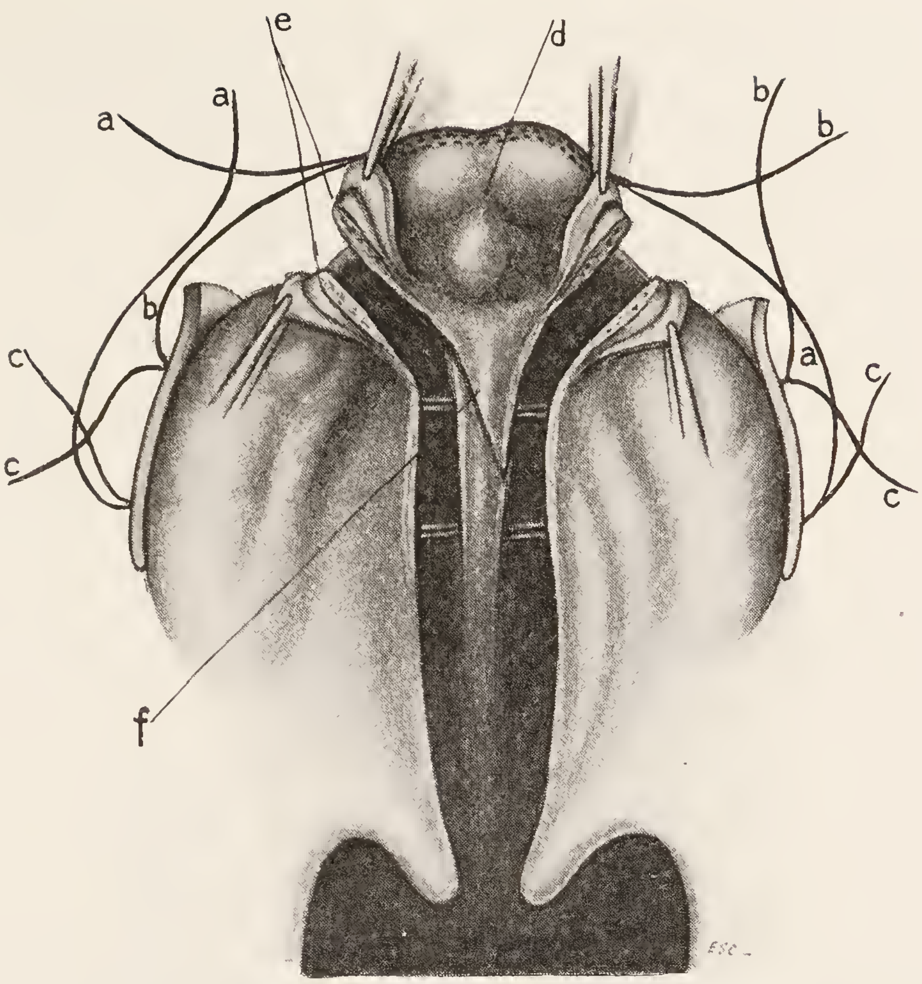


FIG. 482.—The second step in the procedure showing the flaps made in the muco-periosteum and the compact bone removed from the surfaces to be placed in contact. It will be noticed that wire sutures have been carried through the maxillæ and the vomer. These sutures will enable the surgeon to bring the bones into close proximity.

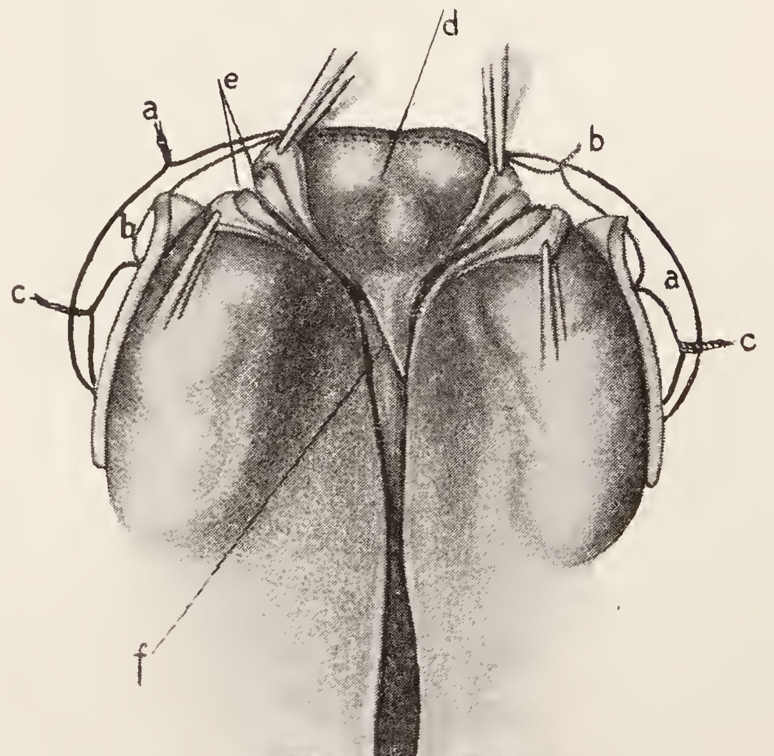


FIG. 483.—The flaps have been made in the membranes and the vomer is in correct position. The wires have been partially twisted. It will be noticed that the wire *a* is brought forward and passed beneath the muco-periosteum anterior to the premaxillary bones and twisted upon the right side. The wire *b* is carried forward in the same manner and twisted upon the left side. The wire *c* is twisted against the lead plate so as to force the separated bones together. The *c* wires are twisted before the *a* and *b* wires.

premaxillary and maxillary bones, which are to be placed in contact, must be freshened, brought in contact and thoroughly immobilized. To secure

FIG. 484.—The premaxillary bones have been placed in their normal position and the flaps sutured with horse-hair. The mucous membrane over the vomer and edges of the hard palate have been split and the underlying bone freshened so that union takes place without placing any sutures in the median line. The soft palate is united later.

immobility, wire sutures are inserted after the manner described under *Form* 7, and lead plates adjusted (Fig. 481). Introducing the anterior wire, the premaxillary bone is not pierced by the needle, but the suture is carried an-

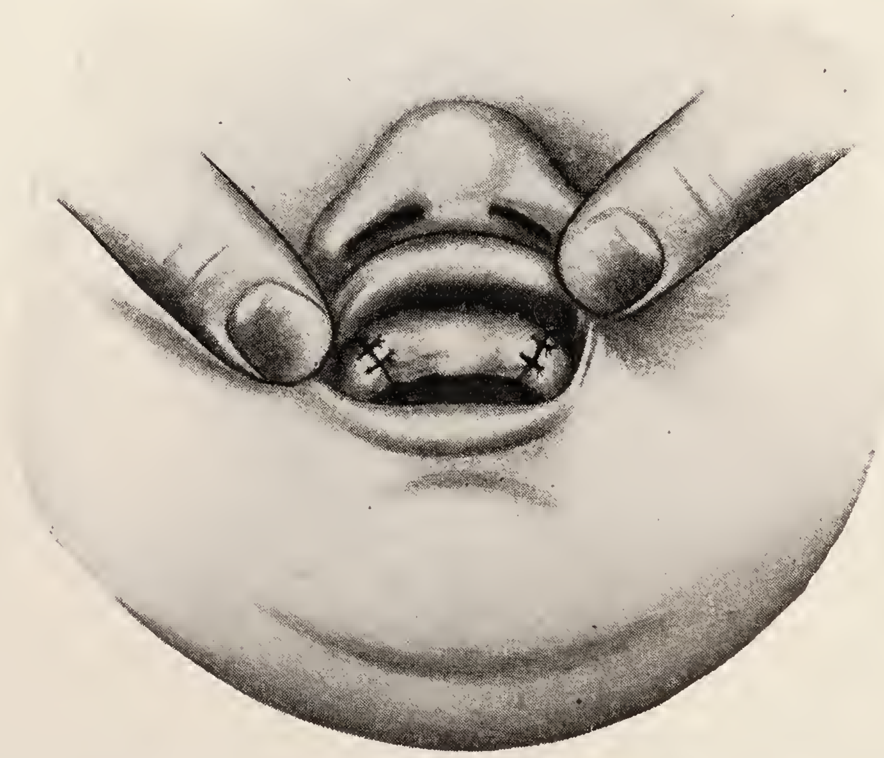


FIG. 485.—Anterior view of finished operation.

terior to the bone, between it and the overlying soft parts (Fig. 482). In this manner the wire, by pressure, carries the bone slightly backward while

the wires passing through the substance of the maxillary bones bring them closer together and in contact with the lateral surfaces of the premaxillary bones. The edges of the bones should be thoroughly freshened and the compact bone removed so as to allow the cancellated surfaces of the bones to meet, thus securing a bony union and a solid arch (Figs. 483 to 485).

Form 9.—*Cleft of the entire soft palate which extends irregularly half way through the hard palate. The anterior portion of the hard palate is united as far forward as the premaxillary bones. The premaxillary bones are entirely separated from the maxillary bones. This rare condition is usually complicated with double harelip* (Fig. 421).

The treatment of the premaxillæ is essentially the same as that described in *Form* 8. The complication of harelip adds to the deformity, but an operation upon the lip in all cases should be deferred until after the bony arch is

FIG. 486.—A cast of a small anterior cleft, through the alveolar ridge only. Form 10.

formed and the bones have become well united. The.posterior cleft is closed at a subsequent operation.

Form 10.—*Cleft only between the maxillary and premaxillary bones. The cleft may be accompanied by harelip, single or double, and protruding premaxillary bone which is diverted to the opposite side. It may be without lip complication* (Fig. 422).

In this cleft a pilot suture is passed from before backward between the central incisor teeth. It emerges near the palatal surfaces of the cleft. Another suture is carried between the cuspid tooth and the first molar into the fissure just above the palatal plate. The anterior pilot suture is carried between the cuspid and molar teeth by the second pilot suture. A double silver wire is then pulled through by means of the anterior pilot suture. The wire now passes through the separated bones (Fig. 487).

The muco-periosteum is incised and reflected forward. The compact bone tissue is removed by means of a knife or chisel. The prominent pre-maxillary bone is carried backward in contact with the other denuded bone by pressure applied by the thumb. The wires are then twisted. The bones are now in firm contact. The muco-periosteal flaps are then sutured with horse-hair (Fig. 488). A normal bony arch is thus formed.

In older patients it is necessary to make an incision through the anterior alveolar plate on the opposite side between the central and lateral or lateral and cuspid teeth as the case requires. Pressure is made on the protruding part of the bone and a green stick fracture produced in the external plate.

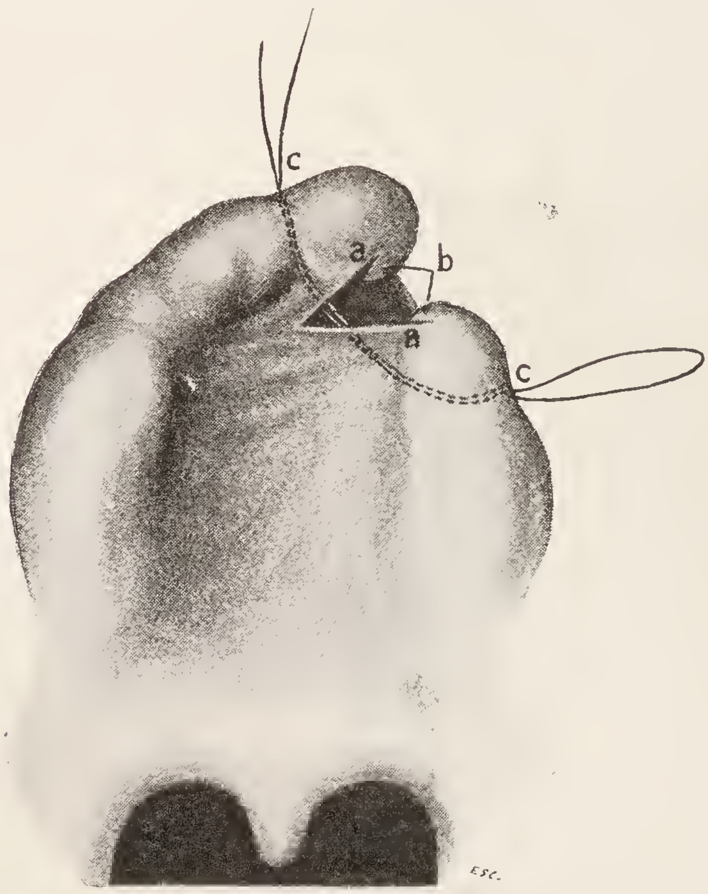


FIG. 487.—This illustrates the introduction of wire sutures to close the cleft. In a young infant the bones can be easily bent and a normal arch formed. After six months, fracture of the bone is necessary to close this fissure.

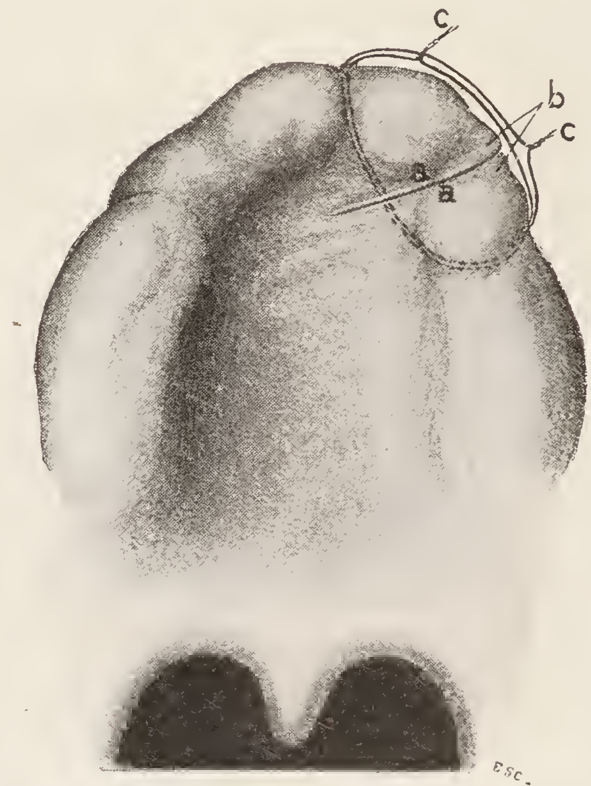


FIG. 488.—Operation completed. The soft parts have been everted so as to prevent the formation of a notch.

This allows the bones to come together. The wires are then passed as previously described and the operation completed.

Overcoming the Notch in the Alveolar Ridge.—By reason of failure of union of the bones, the anterior borders of the cleft are curved or rounded. It will be seen that an approximation of these rounded borders would leave a notch in the bony ridge. To prevent this I have recently modified this portion of the operation by making two flaps, lifting them up and uniting them with horsehair in such a way as to leave, at the time of the operation, a slight projection along the borders of the bone. This secures a smooth, well-formed, normal and solid arch. Previous to this modification it was my practice to remove the mucous membrane and compact bone without making the flaps.

It is a fact well recognized by every experienced, observing surgeon that the teeth in immediate contact with the border of the cleft are frequently of a very poor quality and invariably so irregular in position as to be of little consequence. Especially is this true of the lateral incisors; they are frequently not amenable to orthodontia. The loss of this tooth in making the flaps for the purpose of overcoming or preventing the permanent defect, which the notch in the bone causes, is of small importance, while the prevention of the deformity is of the greatest value. It is not necessary to remove the germ of the cuspid tooth nor even the lateral incisor in making the flaps that I have mentioned.

Fig. 489.—Plaster cast showing a broad cleft of the alveolar process.

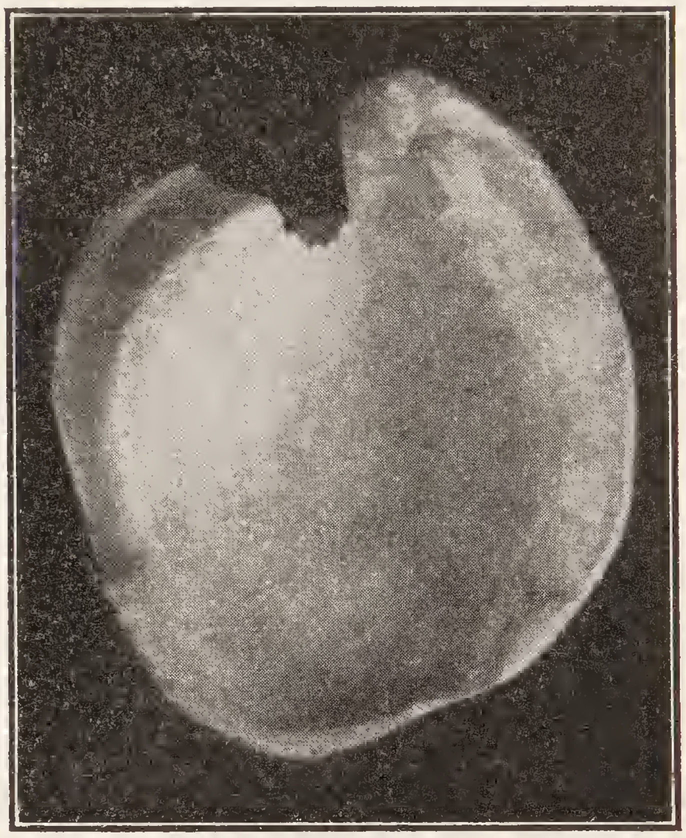


Fig. 490.—Plaster cast showing a cleft through the alveolar ridge only. The central incisor teeth are erupted. The removal of the deformity is more difficult since the bones cannot be moved into position without fracture.

When the child is about fourteen months old the soft palate should be closed as described in the treatment of older patients.

The treatment of this form of cleft is the same as in *Form* 11.

Form 11.—*Cleft completely separating both premaxillary bones from the maxillary bones* (Fig. 423).

This deformity is quite common. The palatal plates of the maxillary bones proper, the horizontal plates of the palate bones and the soft palate throughout its entire length are normal. Occasionally the premaxillary bones protrude considerably, forcing the segment of the lip towards the end of the nose and sometimes beyond (see Harelip). The treatment to be employed in the management of this deformity is to establish the continuity of the alveolar border by carrying the premaxillary bones backward to their place

and immobilizing them there by the use of wire sutures, freshening, as in previously described operations, the surfaces which are brought into contact (Figs. 491 and 492).

Form 12.—*Cleft only of the anterior one-third or one-half of the hard palate with protruding premaxillary bones. The latter are entirely separated from the maxillary bones. This condition is usually complicated with double harelip, partial or complete* (Fig. 424).

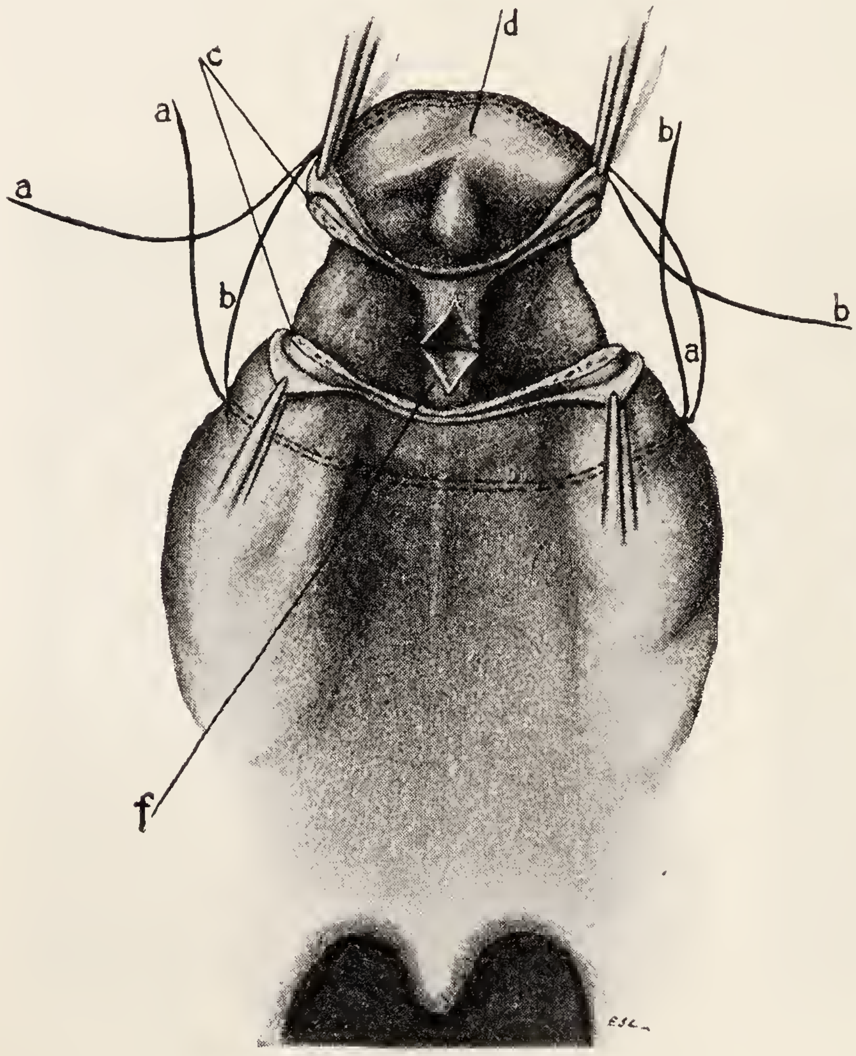


FIG. 491.

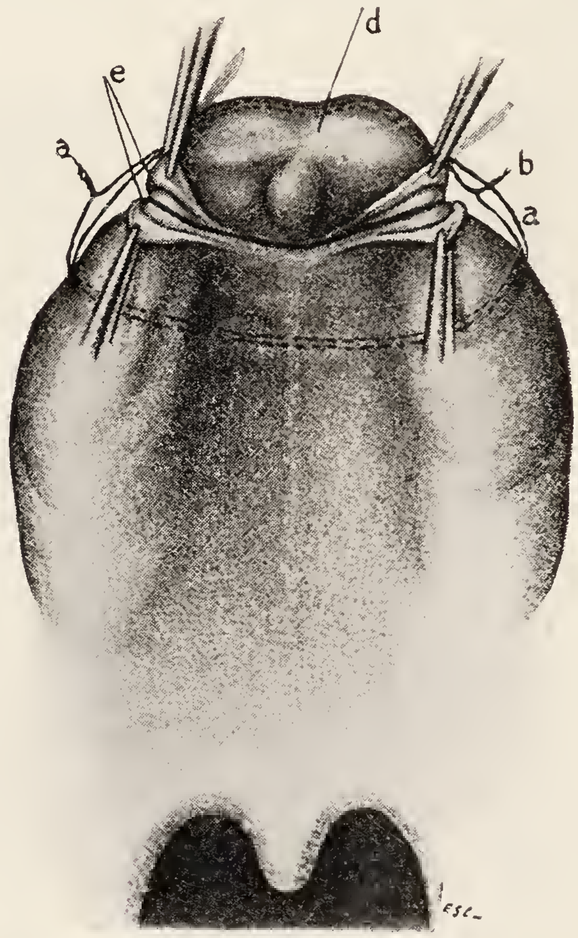


FIG. 492.

FIG. 491.—Shows method of closing Form 11 cleft. The muco-periosteum has been reflected outward (none has been removed), the compact bone removed and wires carried through the maxillary bones and anterior to the premaxillary bones. A V-shaped piece has been taken away from the vomer so as to allow the premaxillary bones to be moved backward into their proper position. The dotted lines show the course of the wires above the hard palate and anterior to the premaxillæ.

FIG. 492.—Showing the wires twisted, the premaxillary bones immobilized and the flaps ready to be sutured with horse-hair. The use of lead plates is not necessary in this operation.

This form is to be treated substantially the same as *Form* 11. The management of the elongated vomer has received a great deal of attention and various methods have been proposed to change the parts so as to establish the contour of the arch. In my earlier practice I was in the habit of removing a V-shaped piece from the vomer, thus enabling me to carry the protruding premaxillæ backward to their place (Fig. 493). More recently I have been making an oblique incision through the lower part of the vomer, then bending the premaxillary bones back into place (Fig. 494). A wire suture, carried through the maxillæ and through the vomer, as described in Figs. 481 to 485,

will enable the surgeon to bring the bones into close proximity, and with the anterior wire carried between the premaxillary bones and the overlying soft parts, he can establish union of the parts and *a firm, bony arch.* Like a fracture, lack of union is due to failure to secure quiet contact.

FIG. 493.—Vertical section of palate nasal region of a child nine weeks of age, showing cleft palate and bilateral harelip and protrusion of the premaxillæ. Protruding bones placed in their proper position and held by silver sutures. Germs of the incisors undisturbed. *a*. Protruding premaxillary bones containing germs of the temporary central incisors. *b*. V-shaped incision in the vomer, indicated by dotted lines.

Form 13.—*Cleft of the entire soft and hard palate extending through the left alveolar ridge. The premaxillary bone is partially separated from the maxillary bone on the right side* (Fig. 425). *This condition could be reversed, but the author has never seen such a case.*

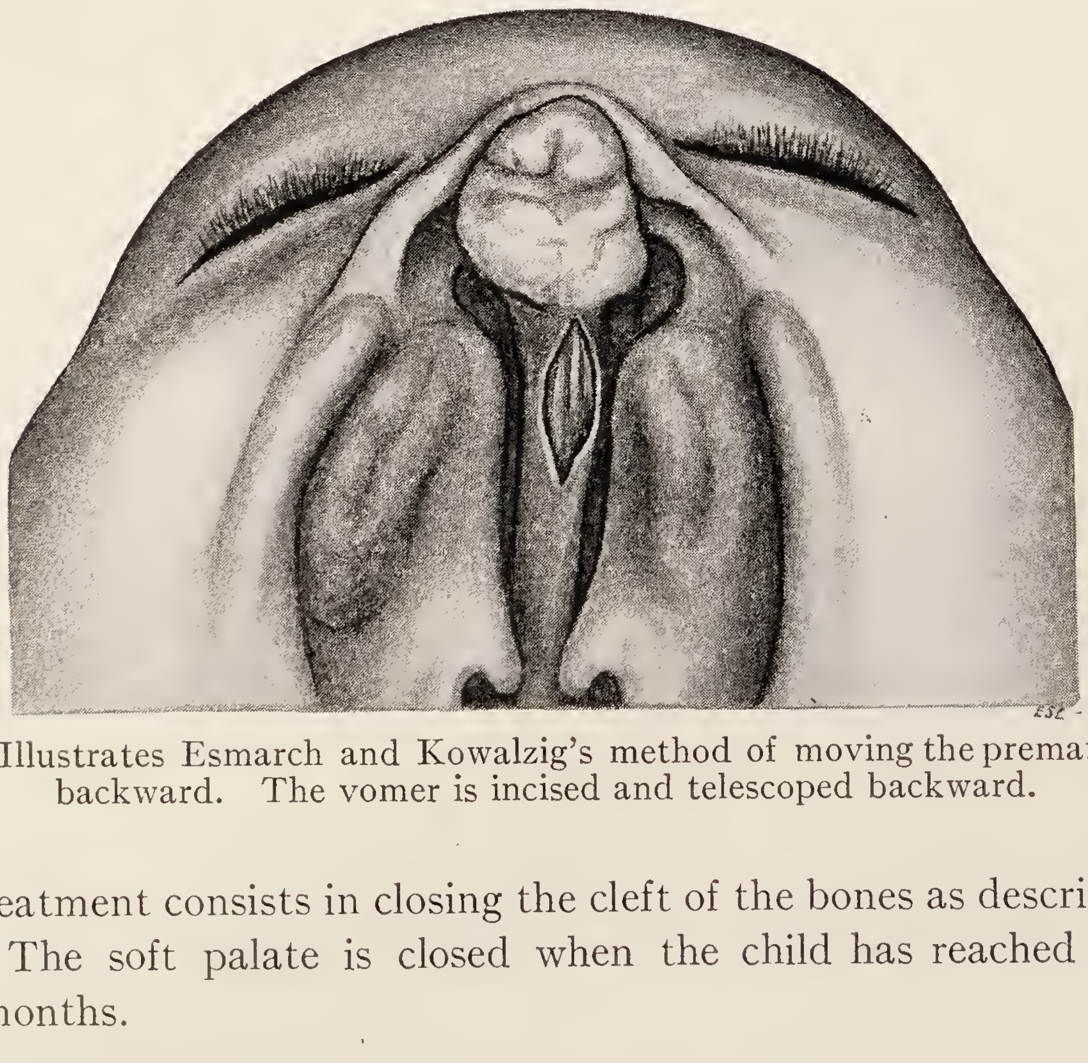


FIG. 494.—Illustrates Esmarch and Kowalzig's method of moving the premaxillary bones backward. The vomer is incised and telescoped backward.

The treatment consists in closing the cleft of the bones as described under *Form* 8. The soft palate is closed when the child has reached the age of 12 to 18 months.

Form 14.—*Cleft of the soft palate, partial or complete, while the hard palate is normal save for a cleft in the alveolar border. The cleft may pass through the alveolar ridge* (Fig. 426).

This cleft is a combination of *Forms* 3 *and* 10. The cleft of the soft palate may extend farther forward. If the patient is under five months of age, the anterior cleft may be closed as described under *Form* 10. The posterior cleft may be closed as described in *Form* 3 when the patient reaches the age of 12 to 18 months.

Form 15.—*Cleft only of the alveolar process anterior to the maxillary bones, due to the non-development or absence of the premaxillary bones. Such cases are usually accompanied by harelip*[1] (Fig. 427).

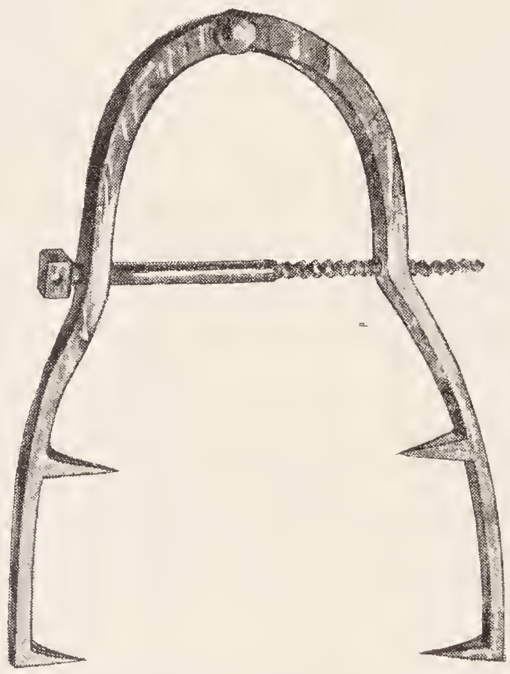


Fig. 495.—Steel clamp formerly employed to approximate the edges of the cleft bones in patients over six months of age.[2]

In the light of our present knowledge, surgery can do nothing to overcome the deformity in this form of cleft. The absence of the premaxillary bones leaves a depression, a large notch in the anterior part of the palate, which must so remain. The literature of the subject furnishes only five examples of the absence of the premaxillary bones and harelip in the median line. The harelip should be closed. When the permanent teeth have fully developed prosthesis can be adjusted. This will supply teeth, correct the recession of the lip as far as possible and establish facial contour.

[1] One case in the author's practice was accompanied by single harelip in the median line.

[2] In 1884 I caused to be constructed a steel clamp (Fig. 495), which was employed in certain cases for the purpose of approximating the edges of the cleft bones. This clamp was capable of accomplishing the work for which it was constructed, but it was finally abandoned as the passage of wires through the bones proved more satisfactory and less irritating and uncomfortable to the patient. Several writers on the subject have also devised steel clamps for this purpose. It is my opinion that steel clamps for the approximation of the cleft of the hard palate will prove as unsatisfactory in the hands of others as they have in mine.

SUMMARY

1. The Brophy operation for the treatment of congenital cleft of the hard palate consists in taking advantage of the opportunity offered in very early infancy, to move the bones in contact when they are soft and easily bent and to carry them into their normal relation.

2. Bone, at birth, is about one-half organic matter, hence the bending and moving of the separated bones of the palate into contact may be easily accomplished.

3. To wait until the bones have become more widely separated and more highly ossified, the teeth erupted and the deformity increased, is to invite complications that should be avoided.

4. It must not be understood that these bones are 'crushed,' as has been said by men unfamiliar with the operation. The bones are not crushed (crushing means comminution). To crush the bones in performing this operation within the first six months of life would be impossible. They are not broken, but, at a time in life when they are soft and flexible, they are bent and moved into correct relation.

5. This operation is attended by only slight hemorrhage, as we divide no vessels. The hemorrhage which occurs is caused only by the passing of the needles and the scarifying of the borders of the cleft just before its edges are brought in contact.

6. The surgical shock is less in a young infant than it would be in an older one. The nervous system of a young child is not so well developed and is not, therefore, capable of receiving the same impressions as it is later in life. Besides, young children usually react better.[1] Moreover, the element of mental apprehension is not present, and we know that alarm and dread are among the most powerful factors in producing shock.

7. If the muscles are brought into action early, they develop instead of atrophy. Hence, a good velum is secured with plenty of tissue, whereas, if the operation is undertaken later in life, the parts, not fully developed through non-use, cannot so easily be made to subserve the same purpose as tissues which develop through natural employment. It is well known that muscular tissue is more perfectly developed through action.

8. In cleft palate none of the muscles of the velum can be normally employed when the parts are un-united, hence they remain in a partially developed condition through life. By operating at an early age, these muscles are brought into use and their development is proportional to other tissues.

9. As a consequence of early operation, there is much less deformity than is the case in a later one, as all the tissues, bony as well as soft, develop naturally and according to accepted types.

10. When the palatal processes of the maxillæ are united, it will be observed that the bones in the development of the alveolar process of the upper

[1] See opinions of authorities, page 609.

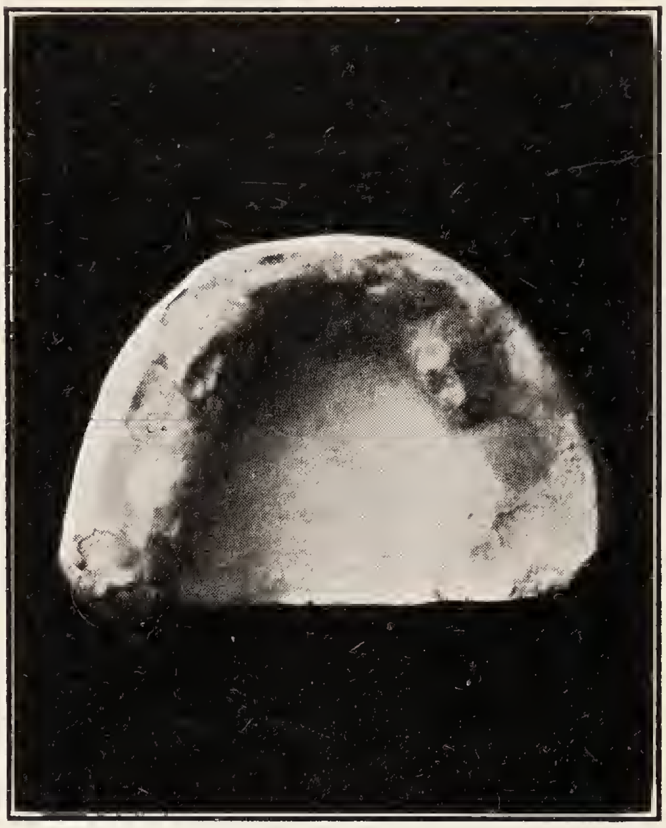


Fig. 496.

Fig. 497.

Fig. 498.

Fig. 496 to 498.—Illustrate the method of moving the bones together in a child fourteen months old. The space between the maxillæ was so wide that the premaxillary bones could not fill it. In three months' time, the bones were approximated by the slow process of twisting the wires upon the lead plates from time to time. The premaxillary bones were then placed in proper position and firmly wired. Fig. 496.—Plaster cast of the lower jaw. Fig. 497.—Plaster cast of the upper jaw before operation. The upper teeth telescoped over the lower. The lower teeth came into direct contact with the mucous membrane of the hard palate. Fig. 498.—Lead plates placed on a plaster cast. The wires are shown passing through the bone and twisted against the lead plates, for the purpose of approximating the bones.

jaw assume a form nearly or quite normal, and when the teeth are erupted they will occlude properly with the lower ones, or nearly so. We restore in *early infancy* the normal relations of the superior maxillary bones by moving them together and holding them there until they unite.

11. In patients not having sufficient bony tissue to close the cleft by this operation without contracting the arch I found, rather to my surprise, that as time passed the bones developed and the arch spread until, when the upper teeth erupted, they occupied nearly or quite the correct relation to the lower ones.

12. The most beneficial result of the early operation is that it permits the normal development of the function of speech. Notwithstanding the fact that the surgical operation on an older child or an adult may produce a good

Fig. 499.—Congenital cleft palate with retrusion of the mandible.

palate in all its anatomical parts, the patient has acquired faulty habits of speech which have become so fixed that special training in phonation will be required to overcome them. In all cases of deferred operations, the patient should be placed, as soon as practicable after the operation, under the instruction of a speech specialist.

13. While realizing there would be a great advantage in closing the entire palate in one operation, experience has shown that the best results are secured in overcoming this deformity by operating in early infancy, first upon the bones and as soon thereafter as expedient upon the lip and finally, when the child is from 12 to 14 months old, upon the soft palate. By so doing normality is produced in all the parts.

14. The child operated on in early infancy will be better nourished following the operation and its general physical condition will improve rapidly.

15. In conclusion, it may be wise to point out the fallacy of operating on the harelip before closing the palate and to show the logic of reversing the sequence. In cases of complete cleft of the hard palate accompanied by harelip, either single or double, the *lip must not be operated upon first.* We cannot, without great difficulty, close the cleft of the bones by transfixing them and secure immediate union *after* the harelip is closed.

When invited by Prof. Dr. August Bier of Berlin to operate on a young infant in the Hospital of the University of Berlin to demonstrate my method of approximating the bones in a cleft of the hard palate, a patient having a complete cleft was not obtainable. However, one was presented, for whom the harelip had been closed. I was requested to bring the bones in contact in this case. I did so, but the operation was performed with great difficulty since the bones were not as easy of access as they would have been if the lip had remained open. Nevertheless Prof. Warnekros reported to me that the operation was entirely successful.

As a rule, surgeons operate on harelip before closing the palate. The deformity is so conspicuous and distressing to parents that the operation is made in compliance with their wishes and to relieve their embarrassment. Three or four years later the operation on the palate is performed. Such a procedure might be likened to half closing a door and then attempting to carry a piano through it. We need the open door because we have a great deal to pass through it. We need, for the transfixing of the bones, all the space the open lip affords. The lip therefore *should not be closed in infants until the bones of the palate are first united.* From one to three months after the bones are united, the lip may be operated upon. The closure of the lip does not materially interfere with the work on the soft palate.

The Late Results of Cleft Palate Operations.—In a paper recently read before the Clinical Congress of Surgeons of North America, in London, July, 1914, I said:

"I have brought from America three patients to exhibit to you their powers of phonation. It is an easy matter to make declarations as to the ability of patients to speak, following cleft palate operations. I do not intend to dwell for any length of time on this phase of the subject. The patients will speak to you themselves and it will remain for you to determine whether the result of the work done, according to my own methods, has been successful, and whether the object desired, in securing for the patients perfect speech, has been attained. The patients were operated on at different ages.

The first one was thirty years of age when the operation was done. She wore an artificial palate for several years before I operated. I have it here. You will observe that this was a very broad cleft, the kind that many surgeons believe inoperable. This cleft was closed without making a Langenbeck lateral incision. As I remarked in my paper, I regard these incisions as absolutely unnecessary for the purpose of closing the soft palate. To effect

a union and secure a soft, flexible, useful palate, the tissues must be elevated, wire tension sutures adjusted and fixed upon lead plates.

You will observe that the palate is soft, flexible, and unmarked by scar tissue, which almost always follows when lateral incisions are made, and that it reaches back to the posterior pharyngeal wall. You will also note that her articulation is perfect. She speaks so distinctly that the most critical observer cannot detect the slightest defect in her voice. This, however, does not always follow an operation which yields the same result as in this case, so far as the operation itself is concerned. Many times where the operation has given equally good results the patient must be taught how to use the lips, the tongue—in fact, all the parts that enter into the formation of speech.

You will notice that all I have claimed regarding the operation for adults is demonstrated to be true in what Miss Miller has said in regard to perfect speech. I am satisfied that such results, provided the palate is not mutilated by the formation of scar tissue, can be secured in nearly all cases, provided the patient is taught the mastery of his vocal organs. It only shows that one who is determined to overcome the habits which were acquired in infancy, and which have clung to her through youth and early womanhood, may succeed in speaking perfectly.

The next patient was operated on when nine months of age. She speaks English, French, and German. Her articulation is absolutely perfect. Her command of these languages is such that no one would suspect that she ever had a cleft palate. The young lady feels that she escaped the acquiring of defective speech because she was operated on before she was old enough to begin to talk.

The third patient was operated on when three months of age. In his case there was a broad cleft of the entire palate with harelip, and the nose was deflected to the side opposite the cleft. On examination you will see that his dental arch is so well formed that one would scarcely realize he had harelip, and you will see that he has normal nostrils and his nose is straight. He also has normal speech. It would be hard to convince the mother of this boy that it would be wise to defer operation for cleft palate until the child is old enough to talk. His teeth occlude well. He has but one tooth absent, and that is the lateral on the side of the cleft, which never erupted. As you know, this tooth is often absent in cleft palate patients. If present, it is so much diverted from its proper position that it has little usefulness. This little boy is now eleven years old; he has made excellent progress in school, and he is one of the best informed boys of his age that I have ever met.

In answer to a question that has been asked regarding the disturbing of teeth in moving these parts together, I would say that in my earlier experience I did disturb teeth in carrying sutures through. I later found that careful manipulation when the point of the needle came in contact with the teeth

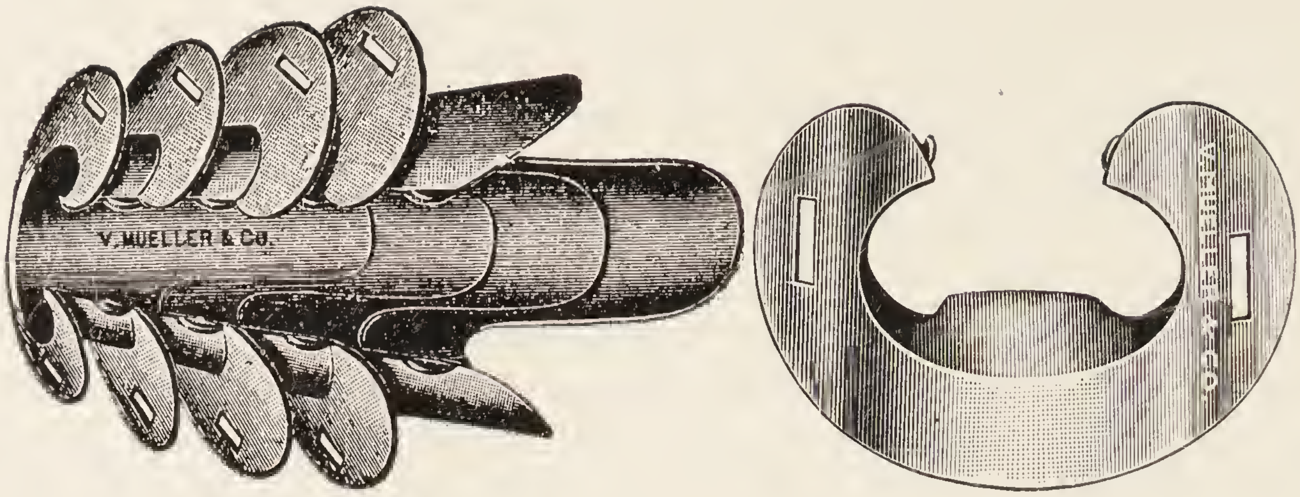


FIG. 500.—Two views of the author's oral speculum. This speculum will give an excellent view of the mouth and will allow the operator to work without interference.

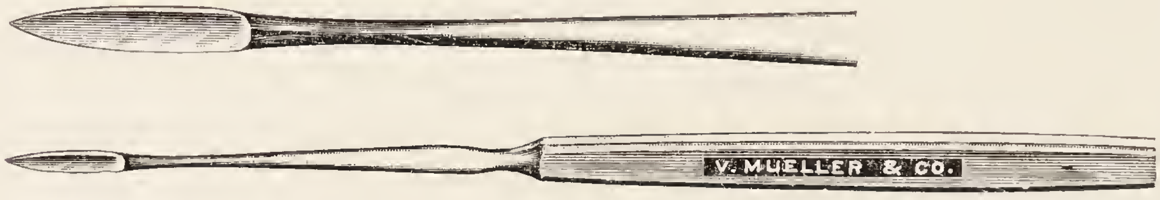


FIG. 501.—Knife used to freshen the edges of the soft palate.

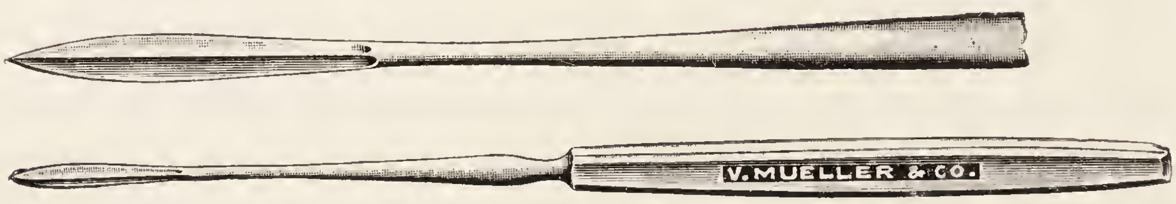


FIG. 502.—Double-edged knife especially adapted for cleft-palate work. It is used to freshen the surfaces of the soft parts.

FIG. 503.—Thin-bladed bistoury with long handle for fine dissection.

FIG. 504.—Curved bistoury sometimes used in repairing holes in the palate.

FIG. 505.—Angular bistoury with a double edge used in repairing holes in the palate.

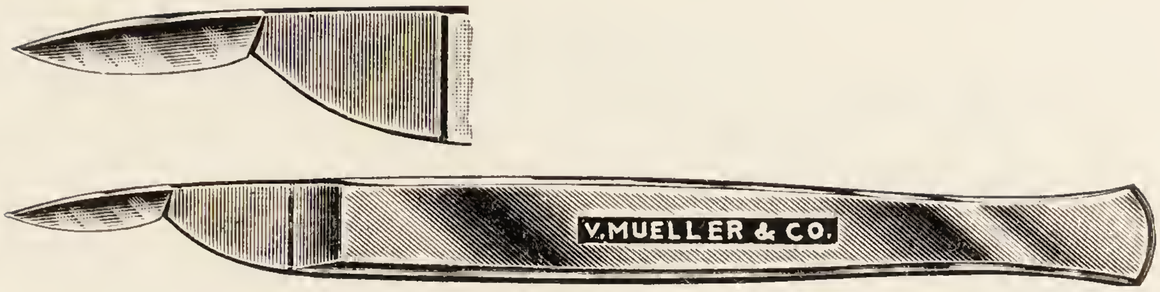


FIG. 506.—Thin bladed knife used in harelip work.

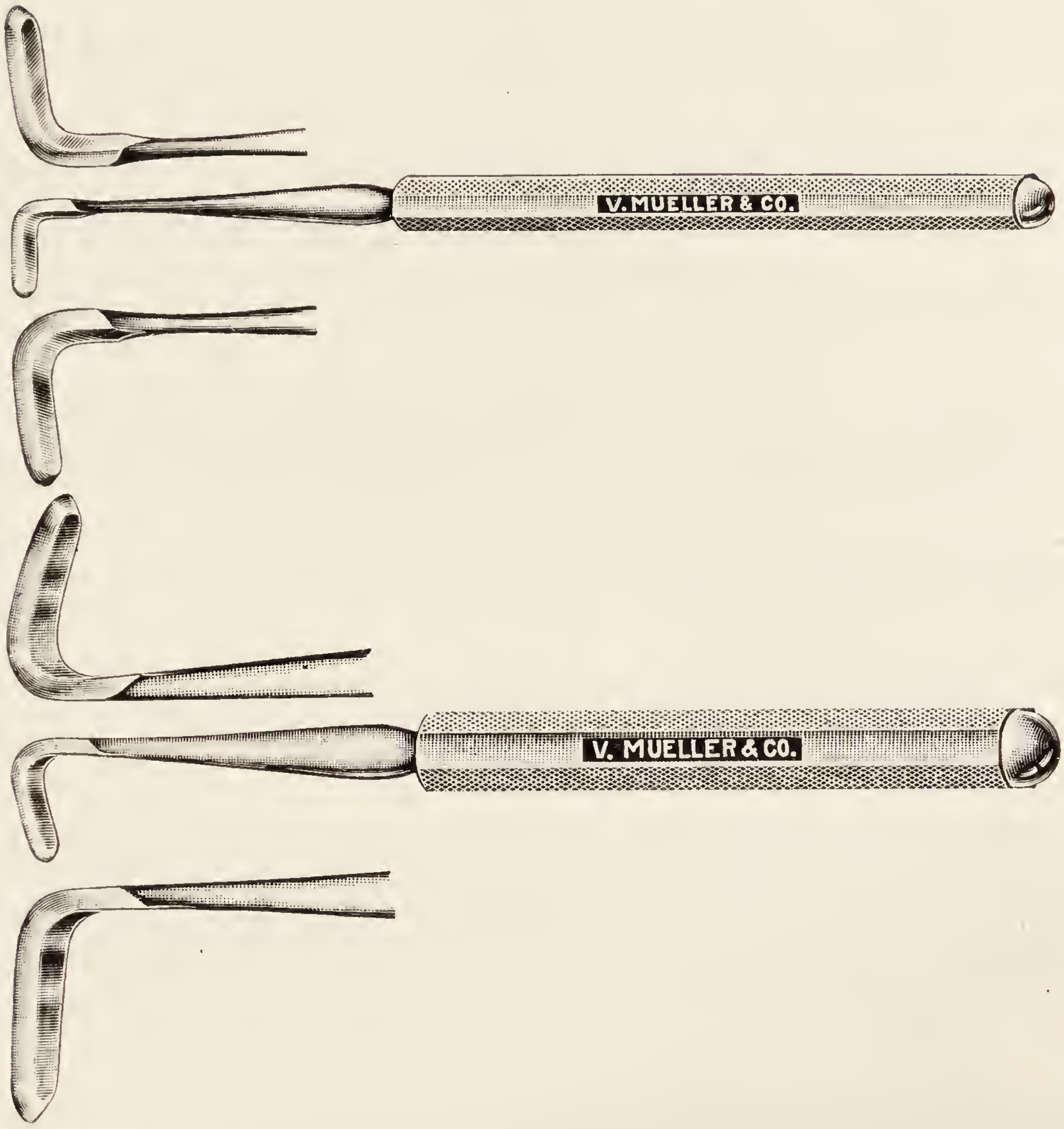


FIG. 507.—Curved periosteotomes for dividing and elevating the periosteum from the hard palate. They are made of different sizes and angles. The smaller size is used in children and the large size in adults.

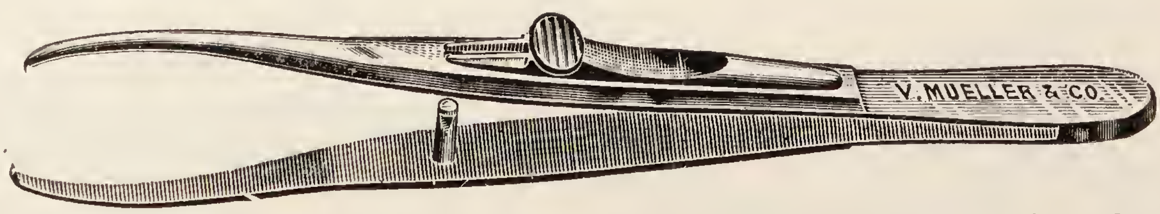


FIG. 508.—The author's modification of the English tongue forceps. When the speculum is in position, this forceps by its weight will hold the tongue out of the field of operation.

FIG. 509.—Long delicately pointed forceps for removing sutures.

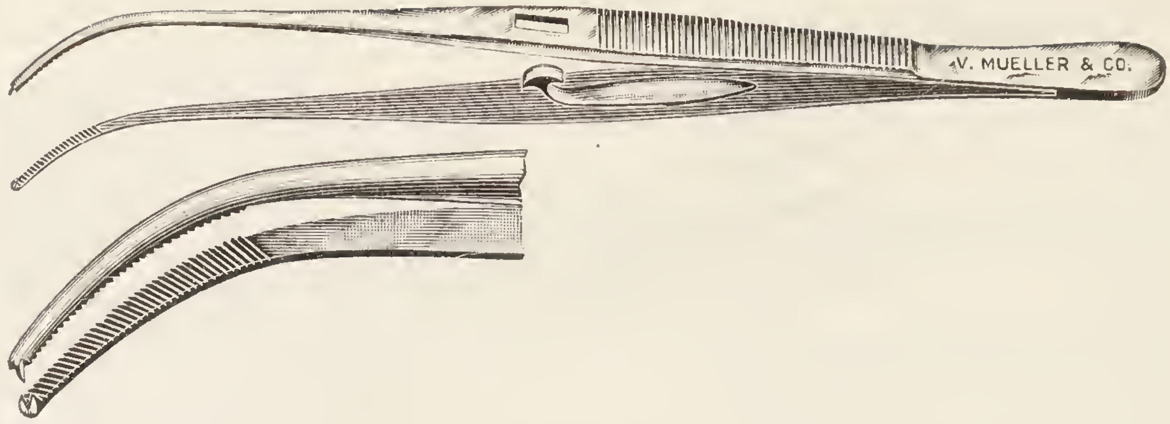


FIG. 510.—Long curved forceps used for sponging and grasping tissue and handling sutures, etc.

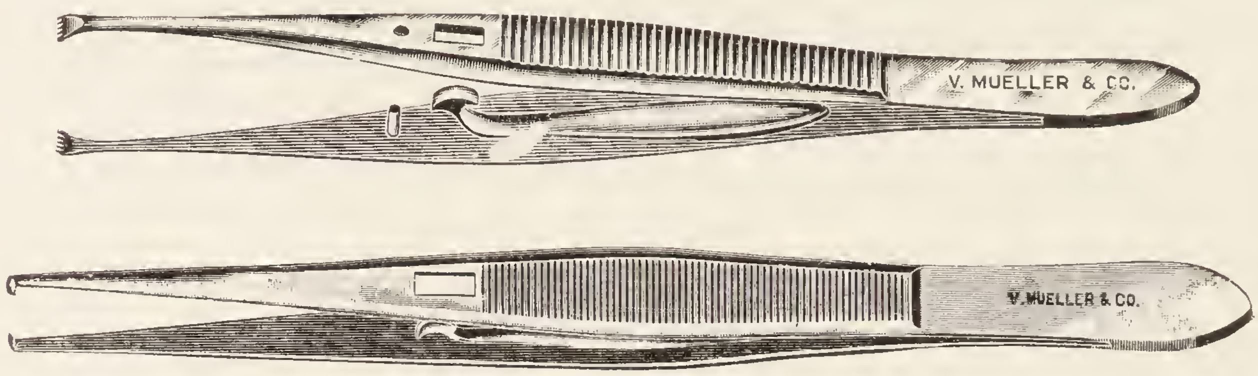


FIG. 511.—Self-retaining tissue forceps used in lip surgery.

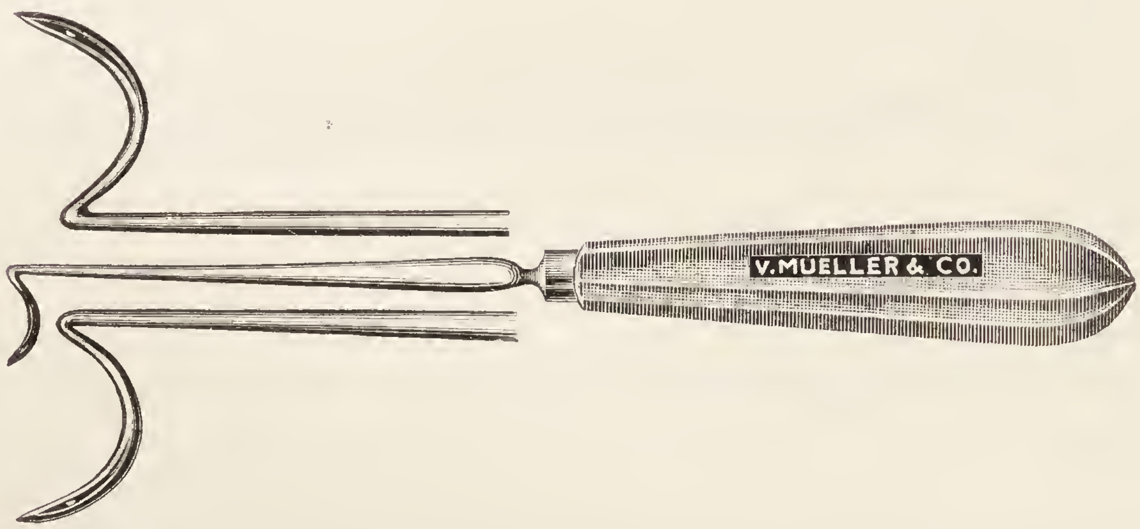


FIG. 512.—Dechamps' needles used for passing pilot sutures through the soft palate.

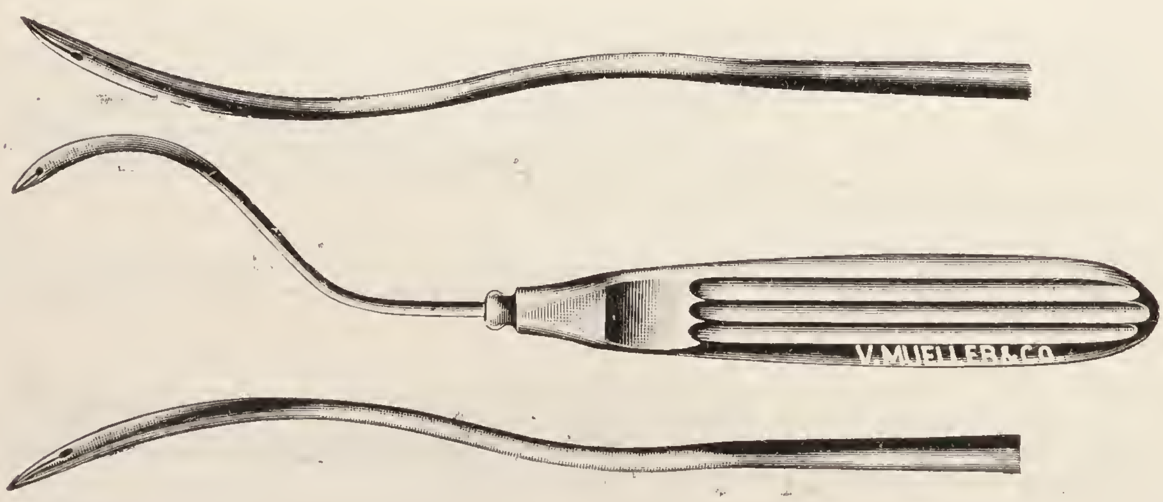


FIG. 513.—The author's strong needles used in the introduction of pilot sutures through the bones preliminary to passing the wire sutures.

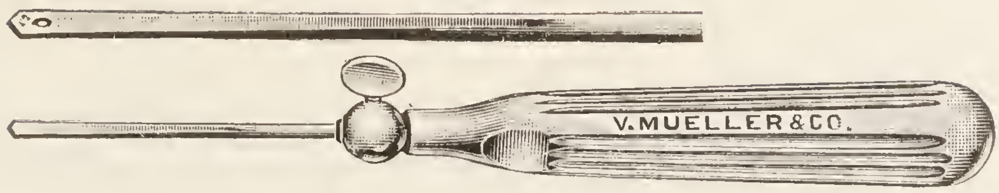


FIG. 514.—New steel drill and suture carrier used in cleft-palate work in infants.

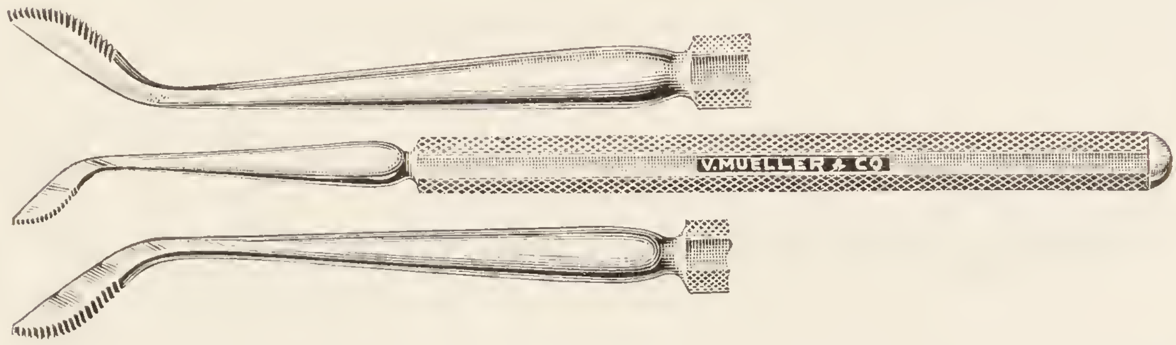


FIG. 515.—Scarifying instrument used to roughen the freshened edges of the bone and soft parts in cleft-palate work.

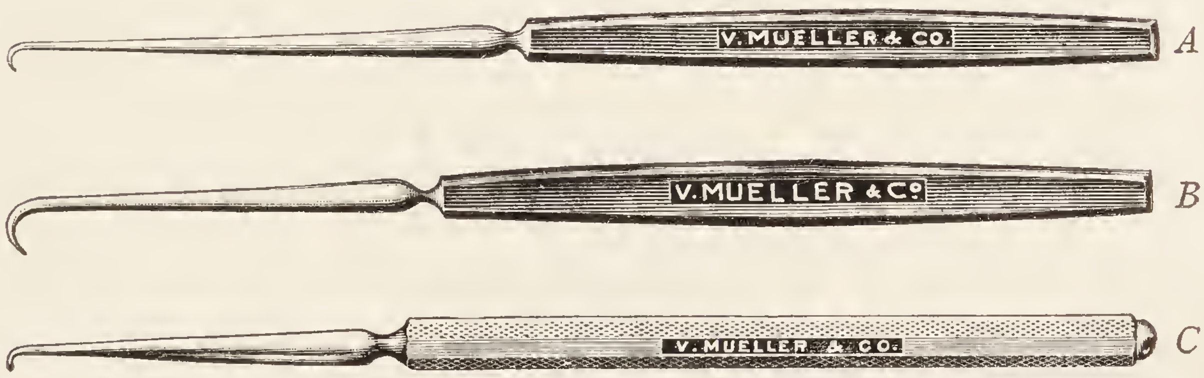


FIG. 516.—Tenaculæ of different sizes used in palate and lip work. *A* has an extremely fine point; *B* has a heavier point; *C* has a right angle dull point and is designed for changing the position of the lead plates after they have been adjusted.

FIG. 517.—Punch used for making holes in lead plates.

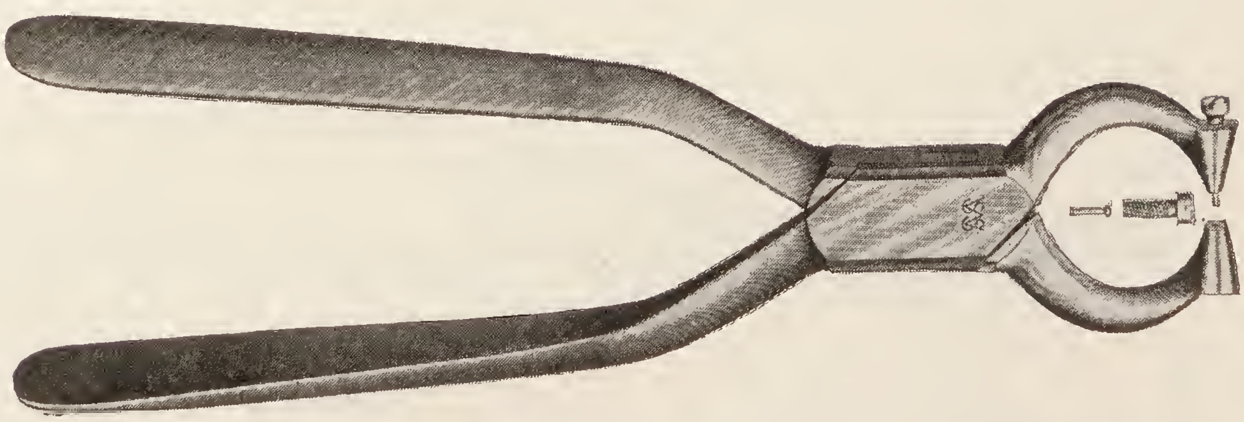


FIG. 518.—Lead punch for making the holes in the lead plates.

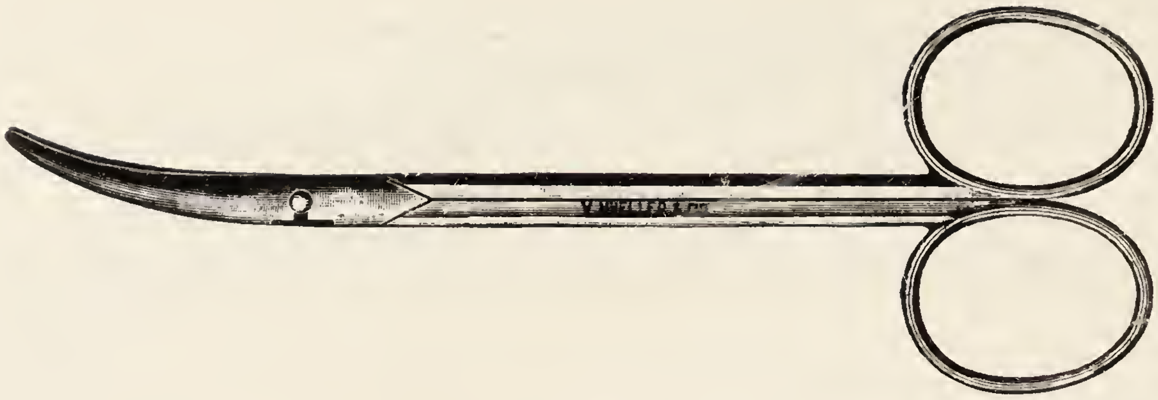


FIG. 519.—Long-handled, heavy-bladed scissors used in cutting wires.

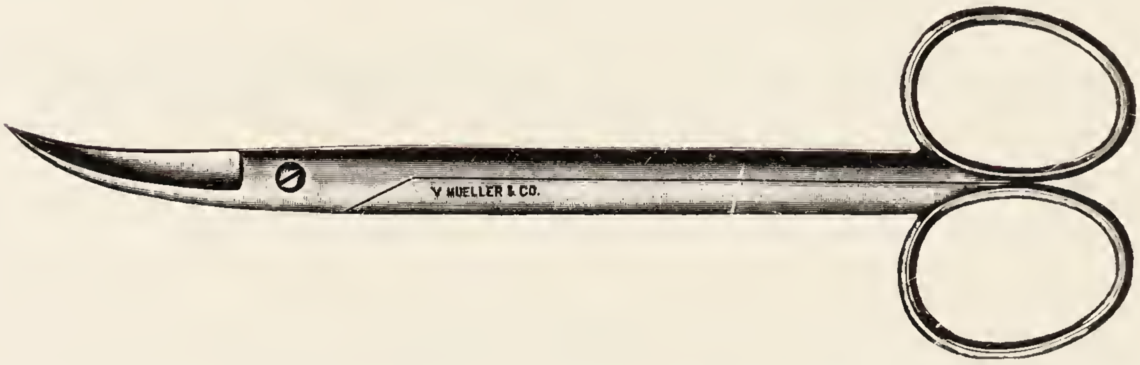


FIG. 520.—Long-handled, thin-bladed scissors used in cutting horse-hair and silk sutures.

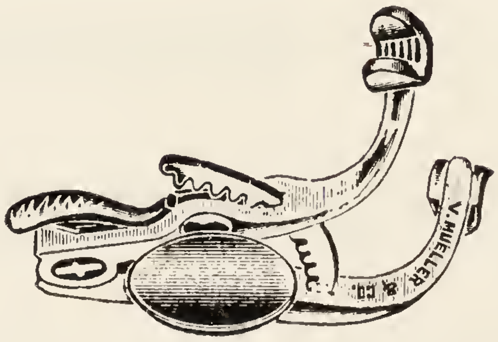


FIG. 521.—Ferguson's mouth gag.

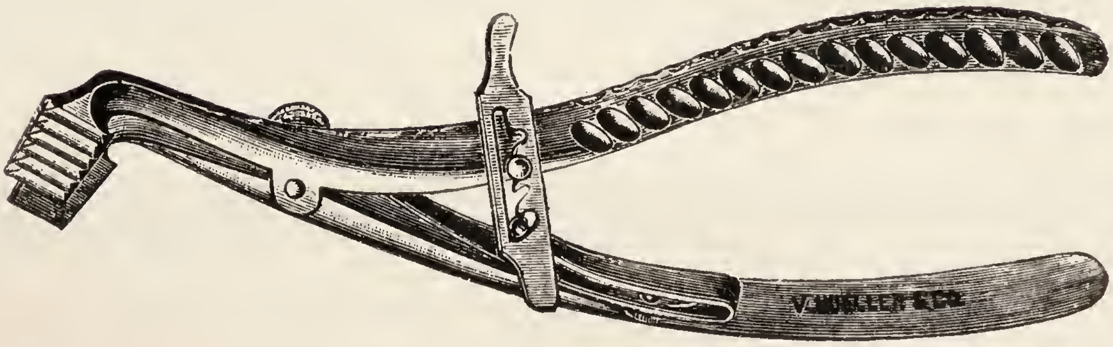


FIG. 522.—Heister's mouth gag.

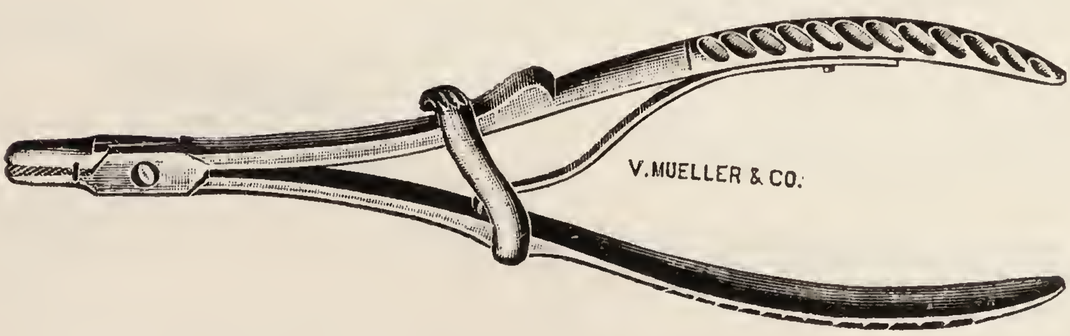


FIG. 523.—Needle holder used as a wire twister.

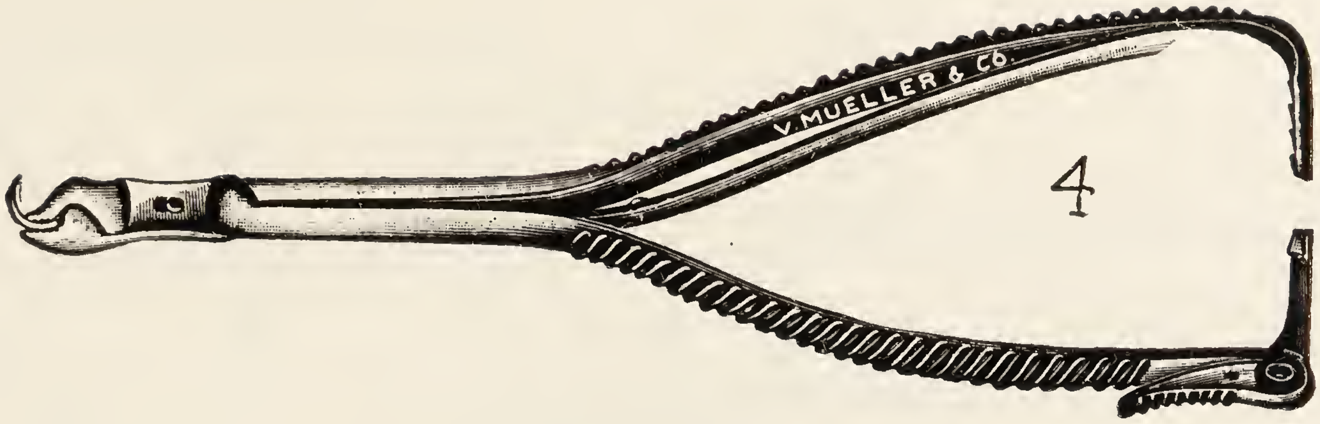


FIG. 524.—Brophy-Truax needle holder.

FIG. 525.—Chisel used to bend the wire on the plates.

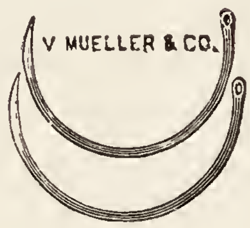


FIG. 526.—Hagedorn needles for suturing the skin and mucous membranes.

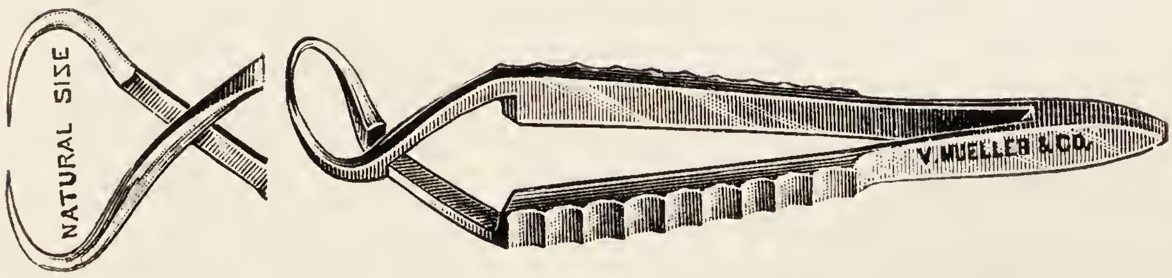


FIG. 527.—Forceps used to hold the towels in place.

FIG. 528.—Flexible pilot suture carrier occasionally used in operations on the palate in infants.

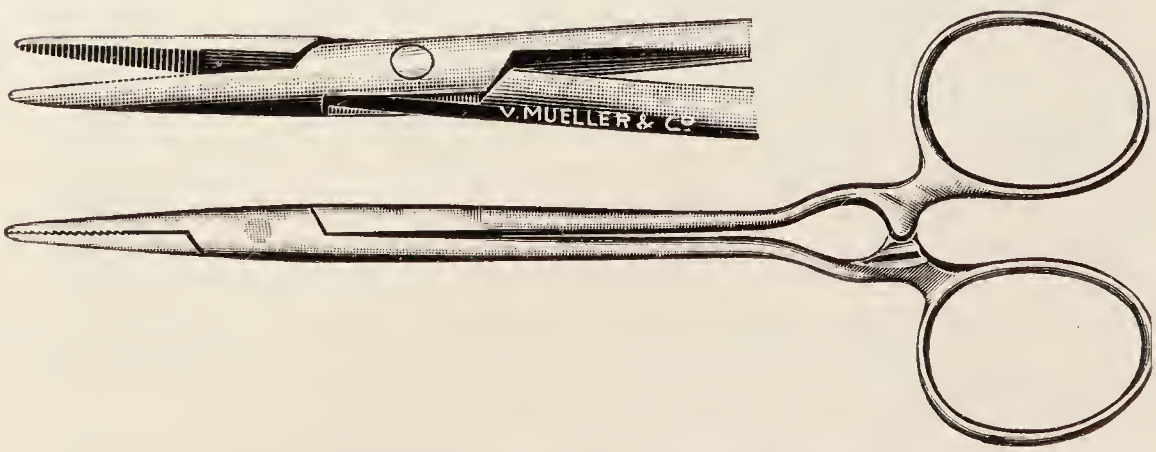


FIG. 529.—Mosquito, hemostatic forceps used in lip work.

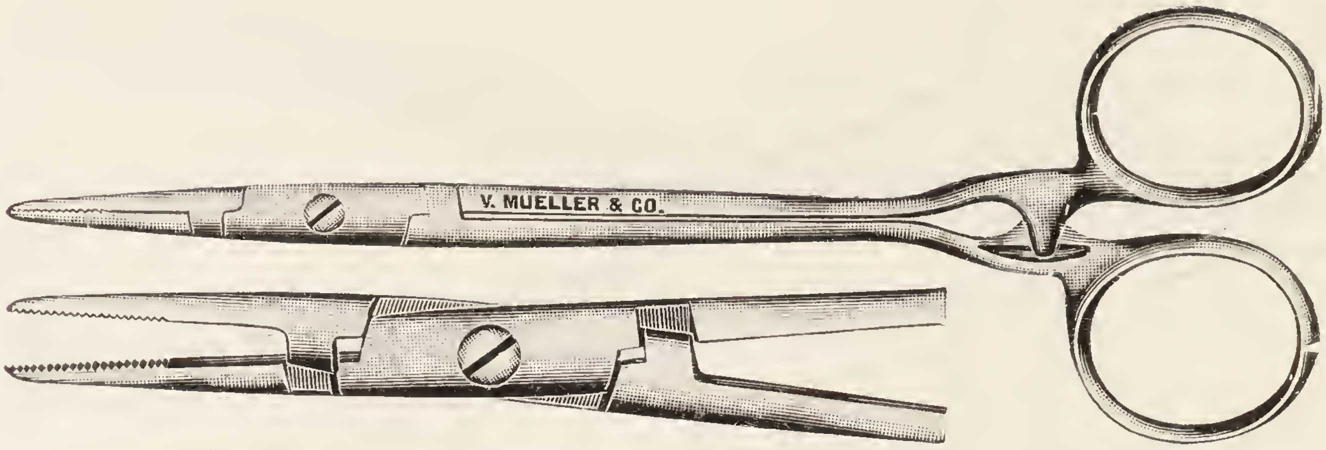


FIG. 530.—Author's fine-pointed, long-handled, hemostatic forceps. The points are held accurately together by the double guides. The shanks are long and narrow so the forceps will not take up much room in the mouth.

FIG. 531.—Author's modification of the Jounker ether and chloroform vaporizer used in cleft-palate and harelip work. The bottles are placed in warm water when ether is used. The foot pump forces the anesthetic into the pharynx.

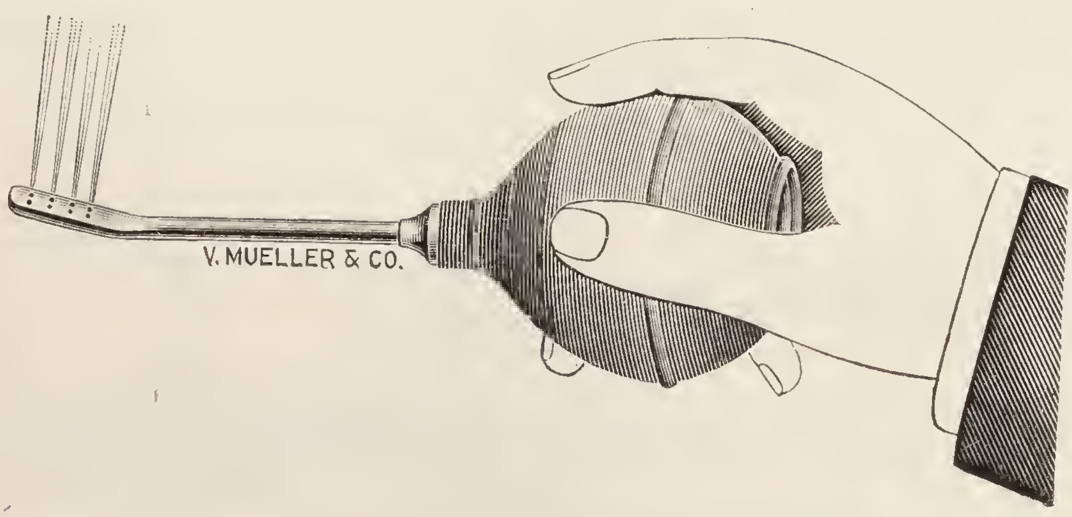


FIG. 532.—The Wooley syringe used in the after-treatment of cleft palate. The boric solution passes through the openings in the point with great force, but not strong enough to injure the tissues. A minimum amount of solution is used.

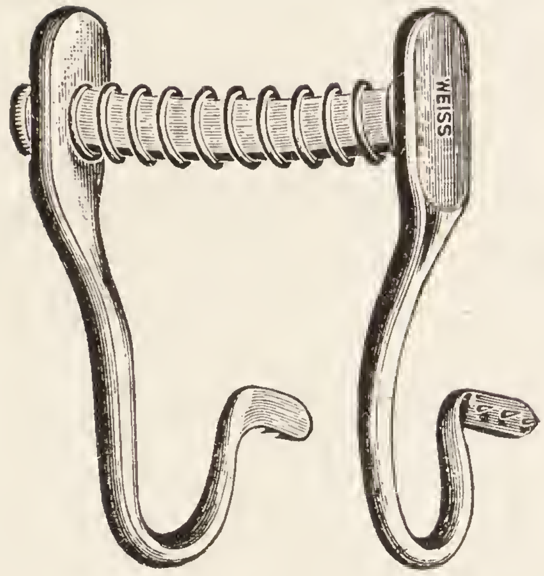


FIG. 533.—Mouth gag. (*Lane.*)

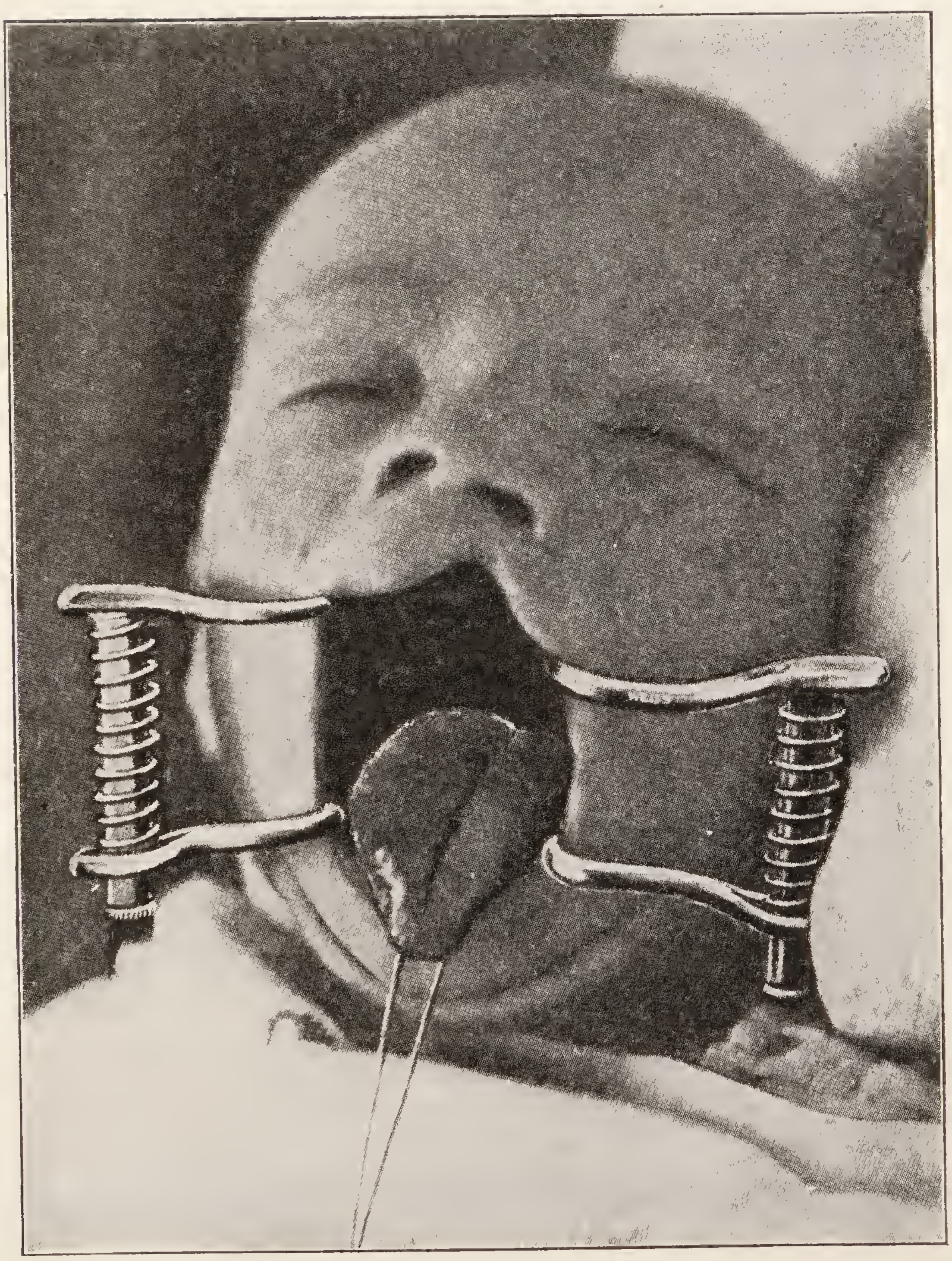


FIG. 534.—Lane's mouth gag. (*Lane.*)

would enable the operator to carry the needle between the teeth and, by so doing, avoid disturbing them."

Lane's Operation.—For many reasons the operation should be performed as early as possible after birth. Before the milk teeth erupt there is plenty of material present to permit the closure of almost any defect no matter how wide it may be. The large surfaces of bare bone left after Lane's operation heal very rapidly.

Instruments required.

1. Lane's mouth gags with sharp teeth which bite into the gums. These are sold in pairs of proper sizes (Figs. 533 and 534).

2. Lane's needle holder with very small needles (Figs. 535 and 536). This was originally devised for suture of the bile ducts.

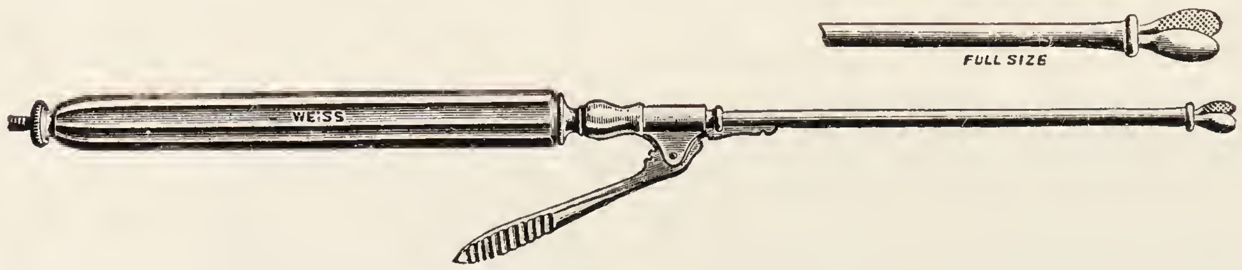


FIG. 535.—Lane's needle holder. (*Lane.*)

FIG. 536.—Needles. (*Lane.*)

3. One small strong knife. A Jones' tenotome will serve admirably.

4. Fine sharp-pointed scissors.

5. One strong hemostat with mouse teeth at the point.

6. Fine strong silk or hemp.

7. A good mouse-tooth dissecting forceps suitable for catching the tissues or the end of a needle.

Type A.—The cleft in the hard palate is unilateral. The septum is continuous with the hard palate on one side. The alveolus and the soft palate are also cleft.

Step 1.—Formation of reflected flap. Make the incision 7, 5, 6, 8, through the muco-periosteum to the bone (Fig. 537). In order to obtain plenty of tissue that part of the incision represented by the line from 5 to 6 is made on the outer surface of the alveolus near the reflection of the mucosa from the alveolus to the cheek. Make the incision through the mucosa of the soft palate, but do *not* injure the musculature. Reflect the outlined flap 7, 5, 6, 8. The pedicle or hinge of the flap corresponds to the edge of the cleft in the palate.

In separating the muco-periosteum from the bone as the posterior palatine foramen is approached, an elevator pressed in between the flap and the bony palate causes the posterior palatine vessels and nerves to protrude for a considerable length in a tube of periosteum. This is readily grasped by an efficient hemostat, which is left in place until hemostasis is assured.

That portion of the flap taken from the soft palate consists of mucosa and

submucosa. It is important not to injure the muscles of the palate. The reflected flap is formed on the side of the cleft which is *not* attached to the septum.

Step 2.—On the side of the cleft attached to the septum proceed as follows: With forceps pull the uvula and soft palate forward so as to expose its nasal surface. Divide the mucosa along the posterior edge of the soft palate (4, 3, Fig. 537). Continue the incision across the nasal surface of the soft palate to the point where the soft and hard palates meet at the edge of the cleft (3, 2, Fig. 537). Continue the incision forward along the edge of the hard palate (2, 1) and across the alveolus (1, 9). The part of the incision affecting the hard palate and the alveolus penetrates the whole thickness of

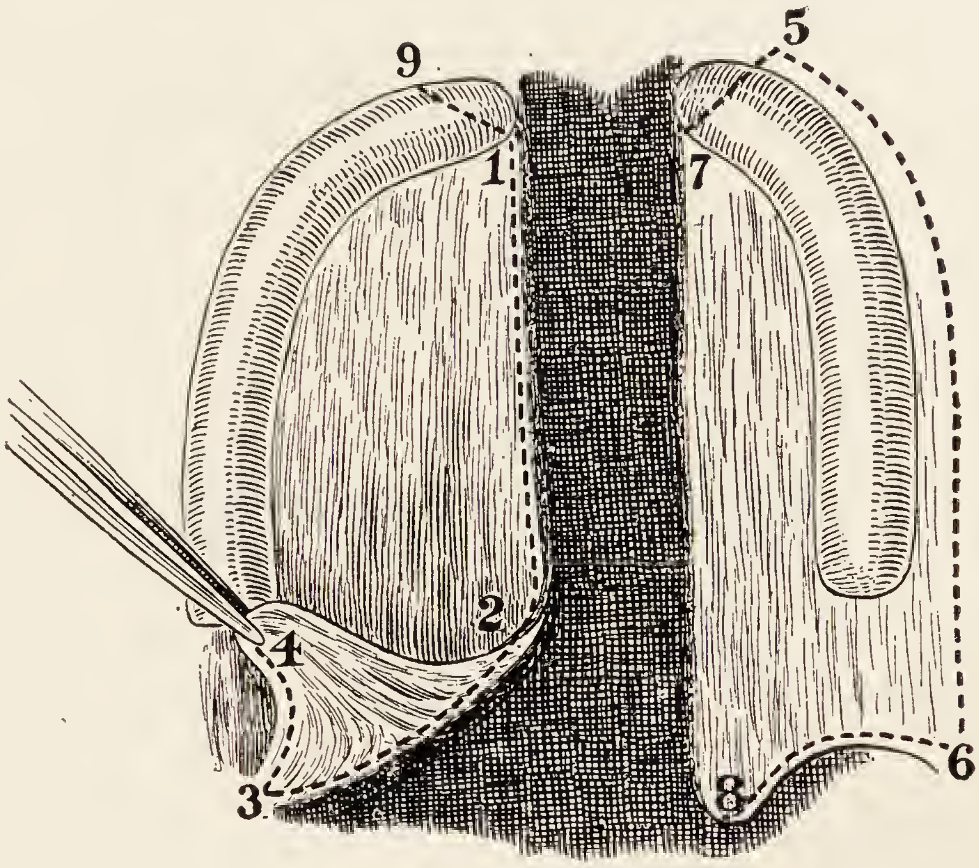


FIG. 537.—Lane's uranoplasty. (*Binnie.*)

the muco-periosteum. The part of the incision affecting the soft palate only penetrates the mucosa and submucosa. Reflect the mucous flap (2, 3, 4) outlined on the nasal surface of the soft palate. Introduce an elevator through the incision 9, 1, 2 (Fig. 537) and separate the muco-periosteum from the hard palate and to a slight extent from the alveolus near the point 9. Divide the attachments of the soft palate to the hard palate along the posterior edge of the latter leaving intact the mucosa on the oral side of the palate. During Step 2 the posterior palatine artery remains uninjured.

Step 3.—Turn the flap 5, 7, 8, 6, so that its epithelial covered surface is directed toward the nose and its raw surface toward the mouth. Tuck the edge of flap 5, 7, 8, 6, well under flap 9, 1, 2, 3, 4, and fix it in position by two rows of fine sutures (Figs. 538 and 539).

Type B.—The cleft is wide; the septum is not attached to the palate; the alveolus is not cleft.

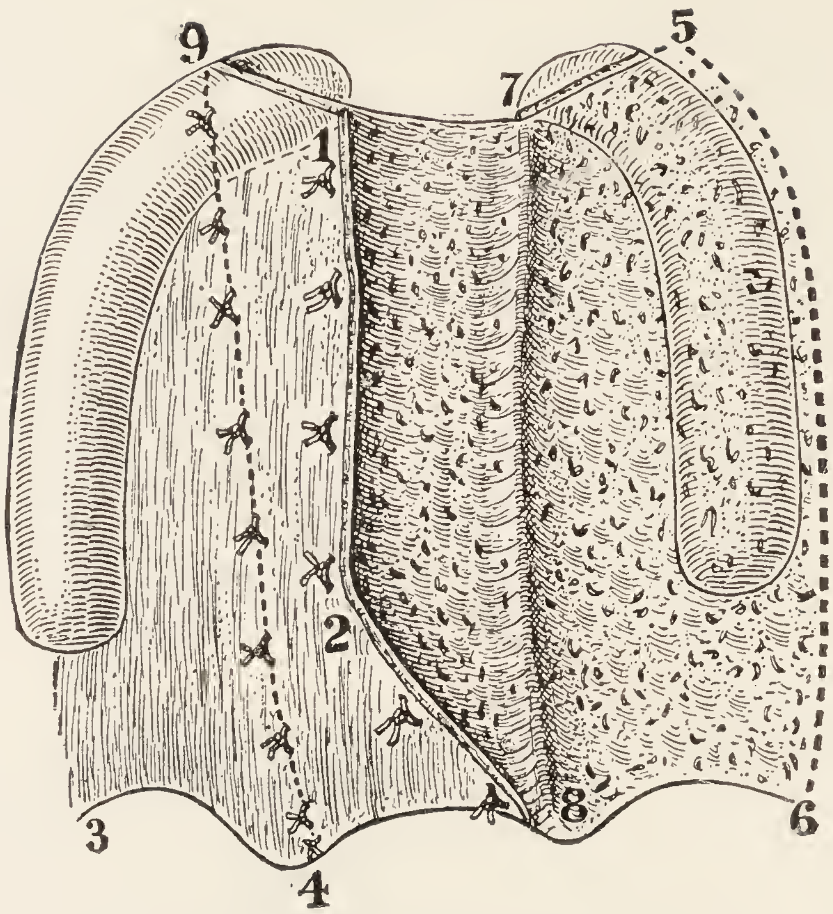


FIG. 538.—Lane's uranoplasty. (*Binnie.*)

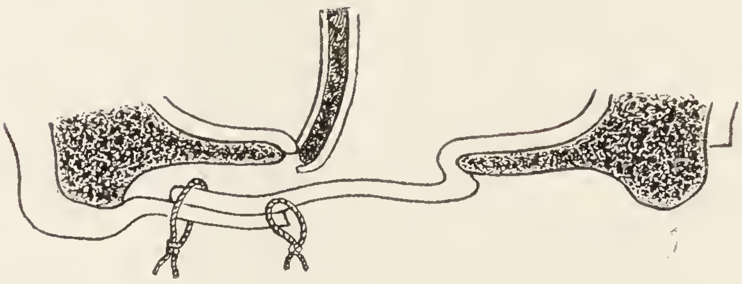


FIG. 539.—Lane's uranoplasty. (*Binnie.*)

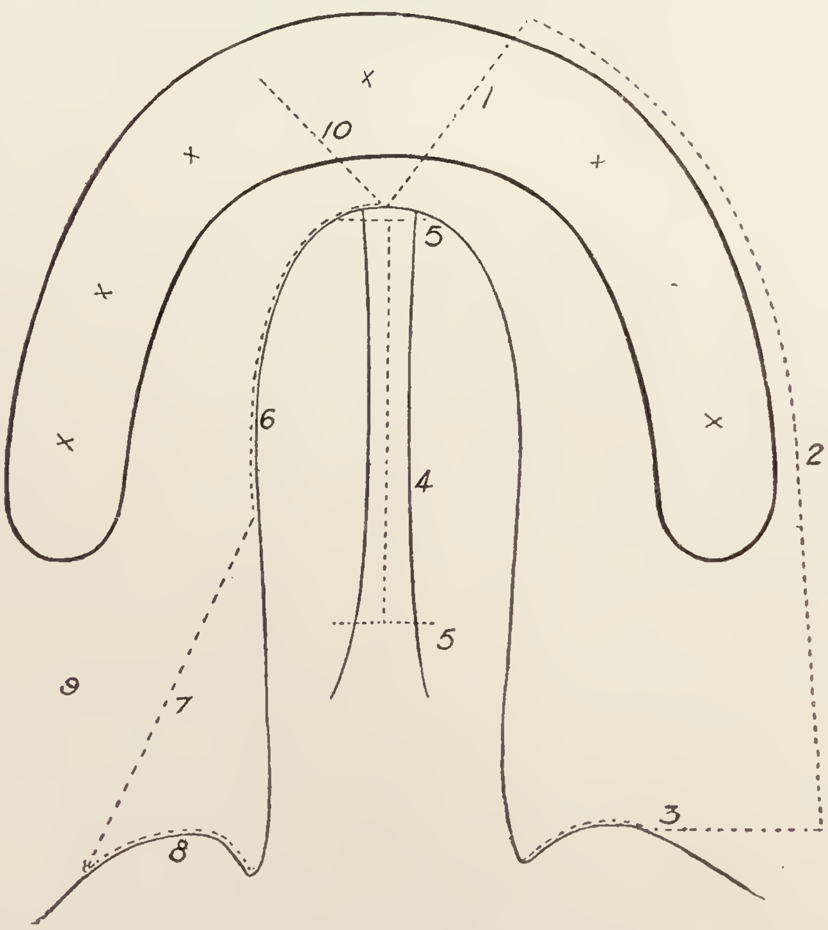


FIG. 540.—(*Lane.*)

Step 1.—Make the flap 1, 2, 3 (Fig. 540) as in Type A.

Step 2.—On the opposite side make the incision 6 through the muco-periosteum along the edge of the cleft. Make the incision 7 and 8 on the nasal surface of the soft palate and reflect a flap of mucosa from the soft palate as in Type A. Separate the muco-periosteum from the hard palate and divide the attachments of the soft to the hard palate along the posterior edge of the latter, leaving intact the mucous membrane on the oral surface.

Step 3.—Turn flap 1, 2, 3 over, with its epithelial surface directed toward the nasal cavity, so as to cover the cleft. Tuck the free edge of this flap well under the flap 10, 6, 7, 8. The triangular portion of this latter flap

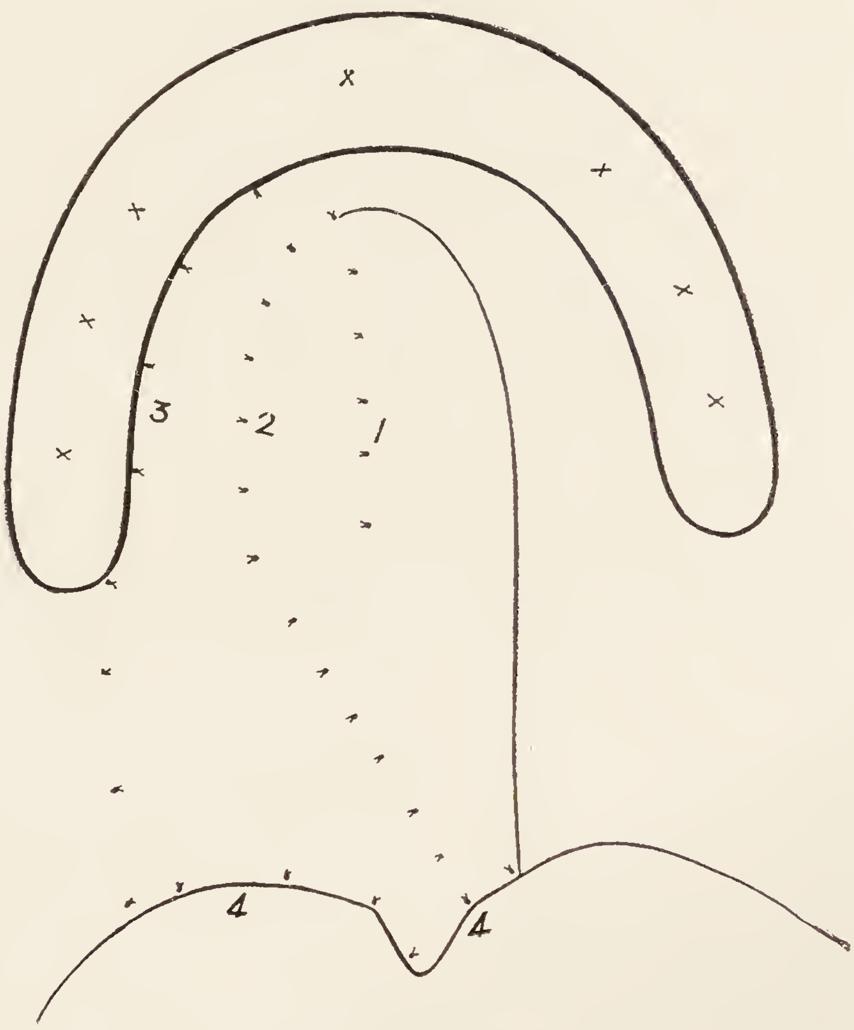


Fig. 541.—(*Lane.*)

which was obtained from the nasal surface of the soft palate assists greatly in providing a thick new velum palati.

Step 4.—Suture the edge of flap 1, 2, 3, to the base of flap 10, 6, 7, 8 (3, Fig. 541). Suture the edge of flap of 10, 6, 7, 8 to the raw surface of flap 1, 2, 3 (2, Fig. 537).

Note.—If the lower or free edge of the nasal septum extends to the level of the cleft attach it to flap 1, 2 and 3 in the following manner after completing step 2 as described: Make an incision (4, Fig. 540) through the mucosa and periosteum or perichondrium along the middle line of the septum with two small transverse incisions (5) at either end, and turn down laterally the narrow flaps so formed, leaving the cartilage or bone bared and exposed. By placing flap 1, 2, 3 in correct position, the line along which it will rest on the septal margin can be readily defined. Along the line of contact with the septal margin denude the surface of flap 1, 2, 3 with a sharp knife.

By a series of sutures perforating flap 1, 2, 3 and the margin of the septum if it be not too hard, or the flaps of muco-periosteum if the edge be bony, securely fix the flap to the septum (1, Fig. 541). Proceed to Step 3.

Type C.—Double cleft palate. Premaxillary bone (P, M, Fig. 542) well in front of the alveolar arch and fixed to the under surface of the nose; the mesial segment (L) of lip is fixed to the anterior surface of the premaxilla. Operation by means of reflected and pivoting flaps. (The following description is in Mr. Lane's own words.)

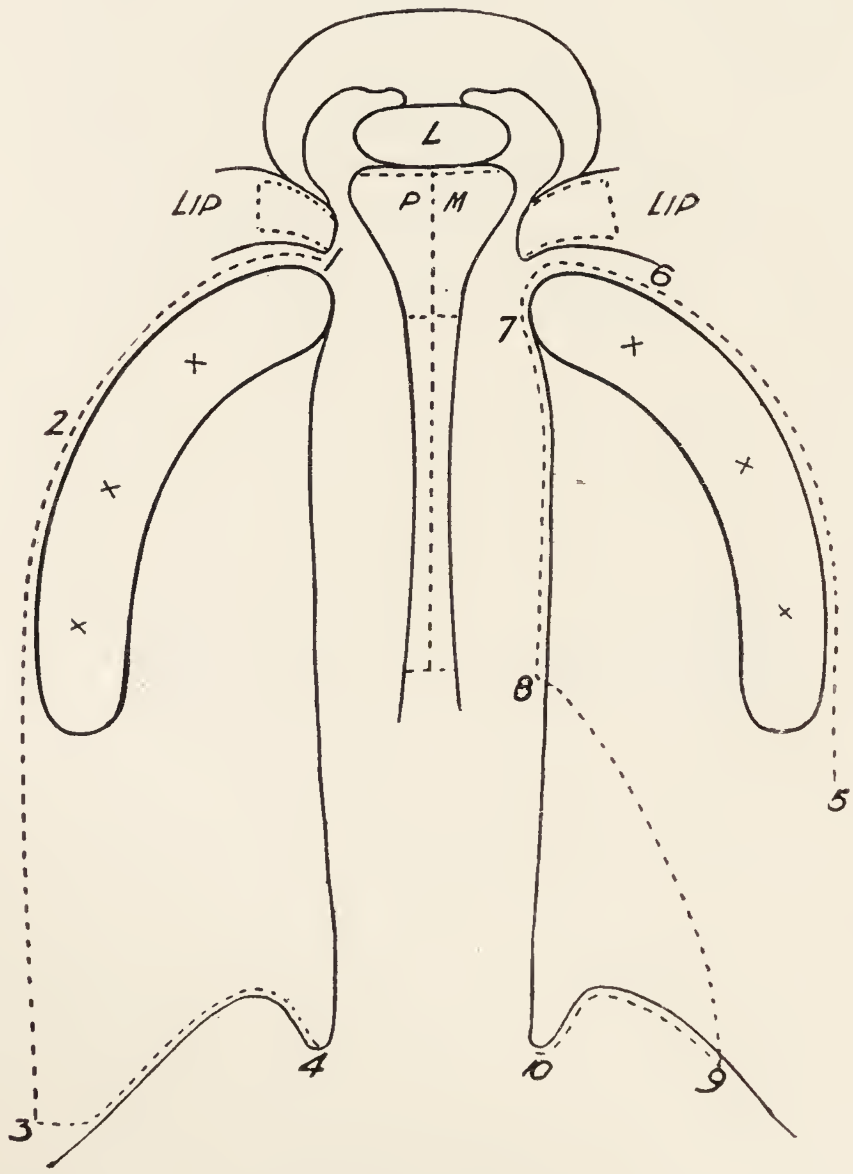


FIG. 542.—(*Lane.*)

"The reflected flap is obtained by an incision extending from 1 along the outer aspect of the alveolus, through 2, and on to 3, when it bends inward along the free margin of the soft palate to the uvula 4. The pivoting flap is obtained by an incision from 5, along the outer aspect of the alveolus, through 6, along the margin of the cleft in the hard palate from 7 to 8, along the upper surface of the soft palate 9, and then to 10.

"The area of mucous membrane corresponding to the triangle 8, 9 and 10, is raised and reflected inward. The area of muco-periosteum included in 5, 6, 7 and 8 is raised from the subjacent bcne, except at the point of entry of the posterior palatine vessels and nerves, which form the pivot on which this flap rotates. The mucous membrane is stripped from the premaxilla

and from the free edge of the septum in the manner indicated by the dotted lines, showing incisions in the diagram.

"Large flaps are cut from the portions of lip forming the edges of the cleft, and great care is taken that they have an extensive attachment at their bases. The mucous membrane covering the lateral and lower aspects of the piece of lip lying in the front of the premaxilla is removed (L).

"The reflected flap is first put in position; the mucous membrane, where it comes into contact with the under surface of the septum, having been

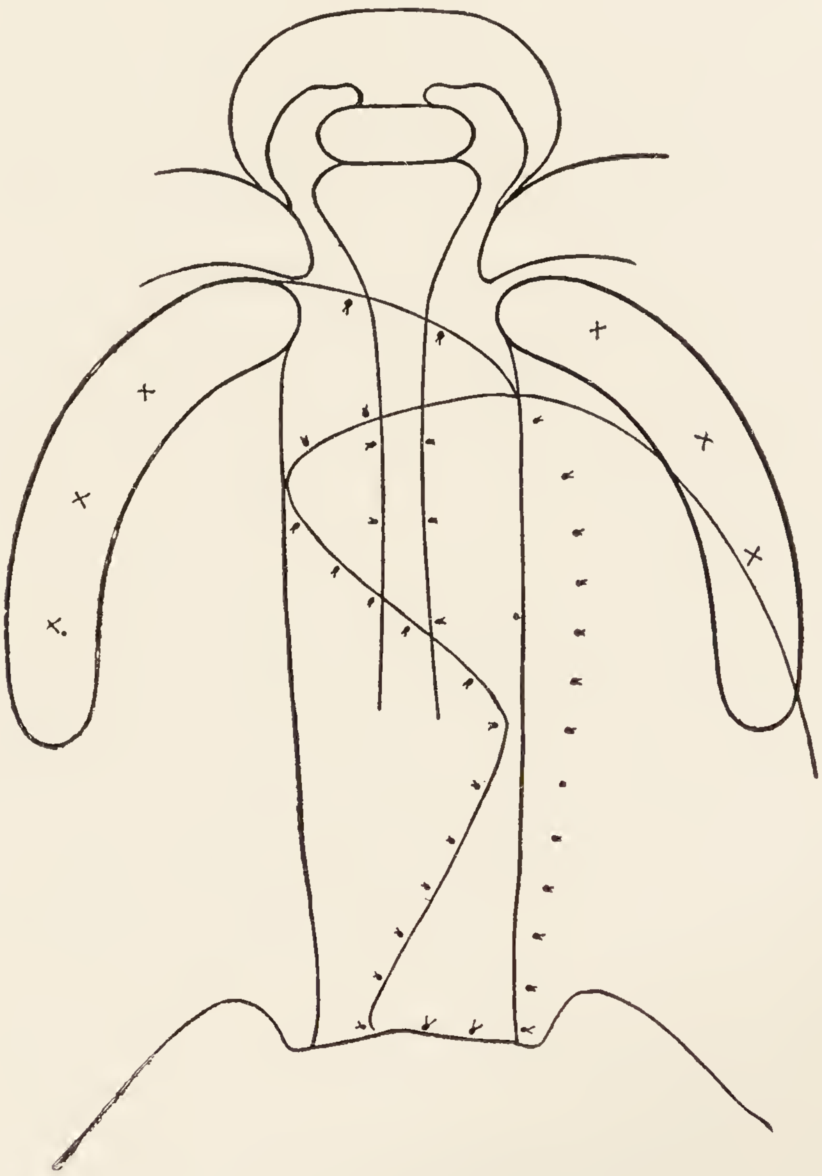


FIG. 543.—(*Lane.*)

rendered raw, is secured to it by sutures. The pivoting flap is then moved inward upon the reflected flap, to which it is united firmly by a double row of sutures. Finally the soft palate is closed in a similar manner. This is represented in Fig. 543.

"After this the triangular areas of muco-periosteum which were reflected from the premaxilla are fixed in position (see Fig. 544), where these are indicated by Y. The flaps from the lips shown as F, F are arranged with their raw surfaces upward. These are united to the raw surfaces of the flaps from the premaxilla and of the reflected flap, and are also sutured by their margins to one another and to the free edge of the pivoting flap (see Fig. 545).

"Lastly, the ala of the nose is cut away from the cheek on either side and is displaced inward where it is united by sutures to the septum, and is sewn

to the cheek in its new position. This I have attempted to indicate in the same diagram. Having brought the edges of the lip into accurate position by means of separate sutures, two sutures of linen thread are passed in the manner indicated in Fig. 546. The needle perforates the lip from behind, and is made to re-enter the anterior aspect of the lip through the same hole,

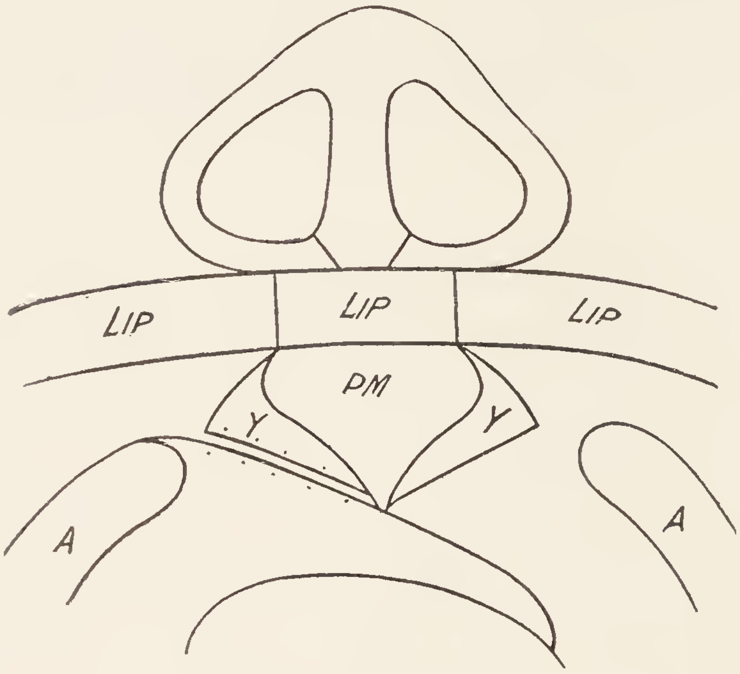


FIG. 544.—(*Lane.*)

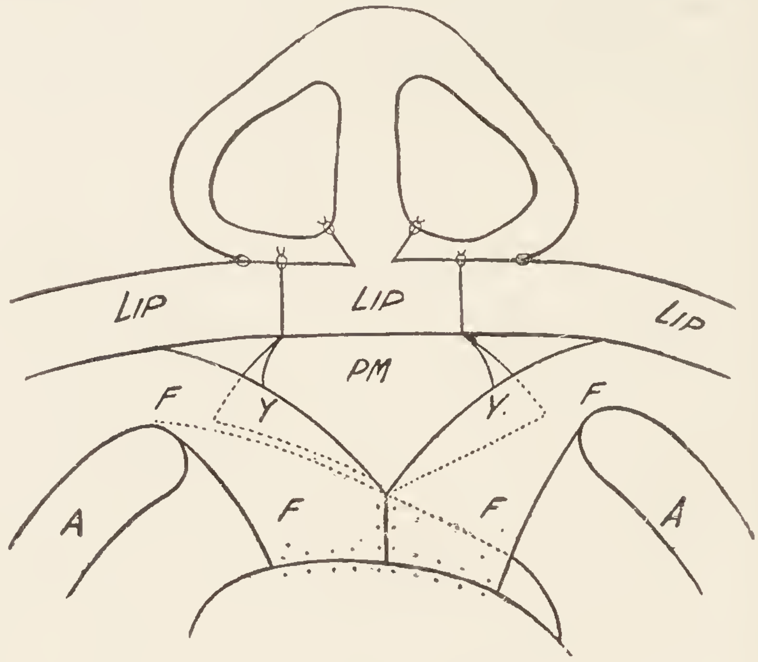


FIG. 545.—(*Lane.*)

and after traversing the lip transversely it again emerges and enters through the same hole, the needle passing directly backward through the lip. When this thread is made taut and tied the opposing raw surfaces of lip are held in accurate position, and no scar whatever results from the presence of these deep sutures, which can be readily removed when they have served their purpose. In Fig. 546 only one cleft in the lip is represented."

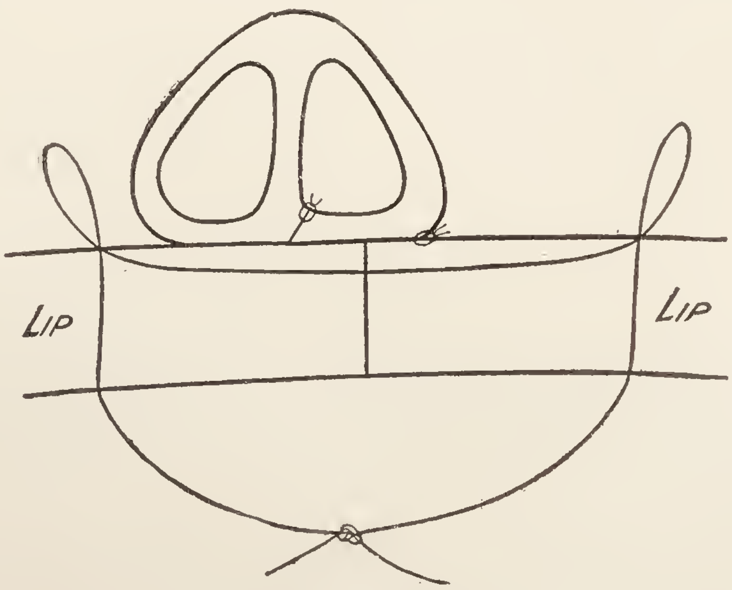


FIG. 546.—(*Lane.*)

Type D.—Wide cleft of soft palate.

Step 1.—Reflect the flap 1, 5, 6, 7, 8 (Fig. 547) with its base at the edge of the cleft.

The flap consists partly of muco-periosteum from the hard palate and alveolus and mostly of mucous membrane from the soft palate and cheek.

The flap must be large enough to easily cover the defect. Do not injure the musculature of the soft palate.

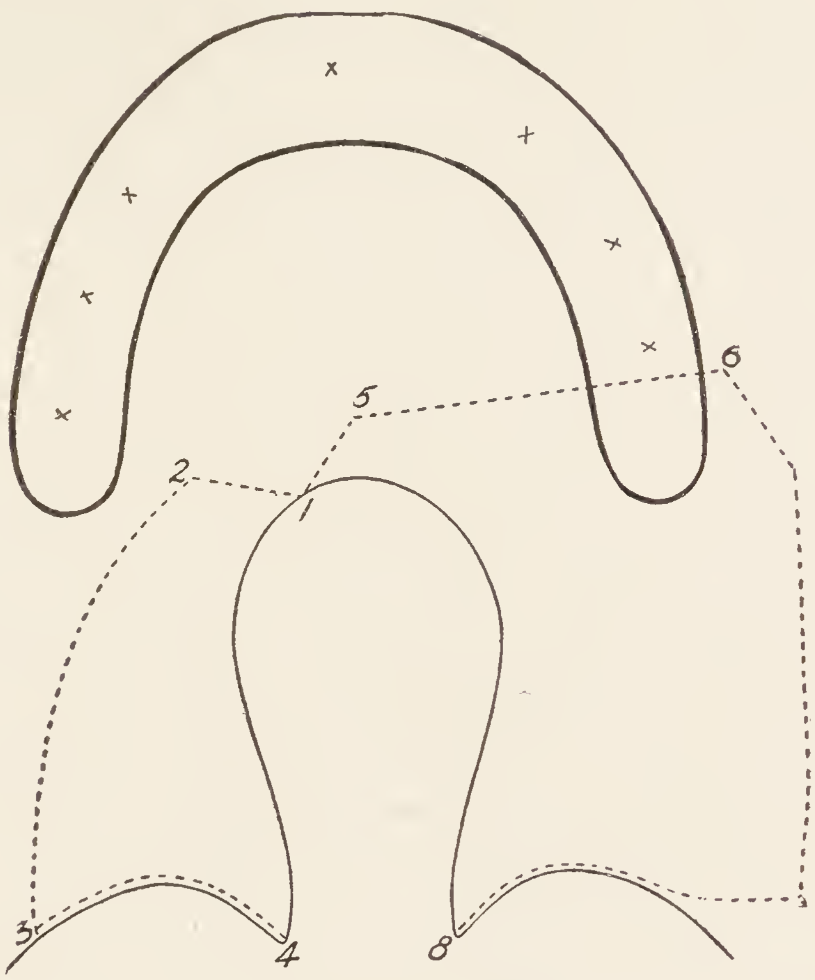


FIG. 547.—(*Lane.*)

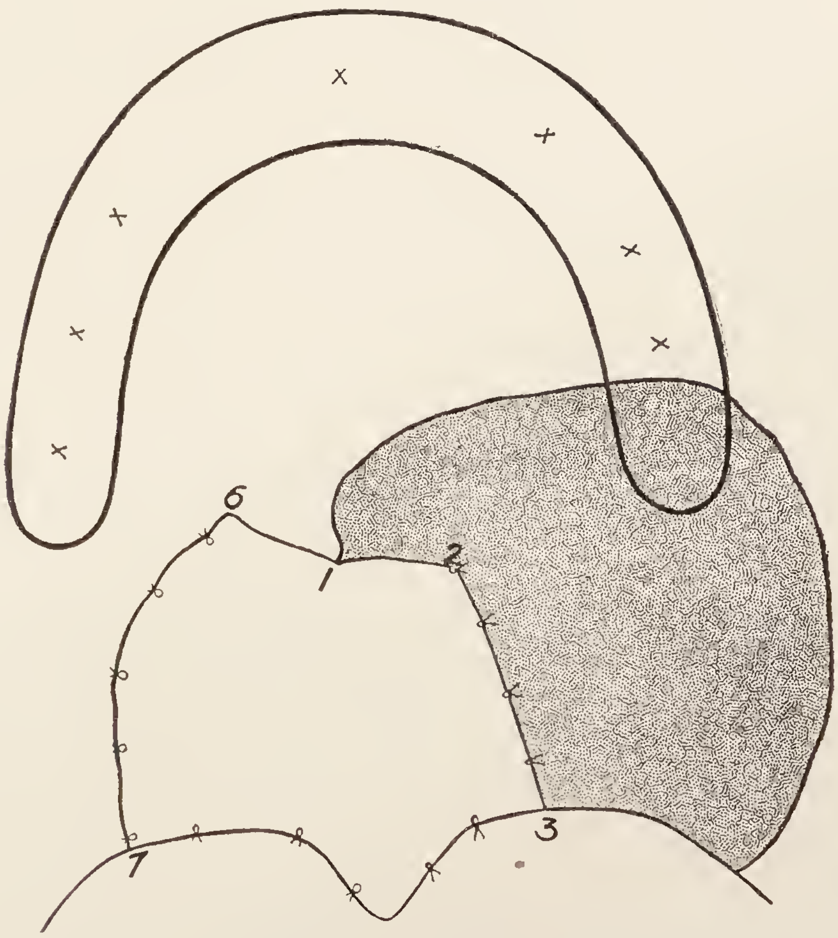


FIG. 548.—(*Lane.*)

Step 2.—From the *nasal* surface of the soft palate on the opposite side of the cleft reflect the flap 1, 2, 3, 4 with its base at the edge of the cleft.

Step 3.—Suture the two flaps together one over the other in an overlapping fashion (Fig. 548).

It will be observed in Lane's operations that the space between the separated bones, or the cleft, is bridged over by tissues, the superior surface of which is mucosa. Now if the periosteum were lifted on both sides and brought in contact so that the superior freshened surfaces were made of periosteum, we would then have as a sequel, by reason of its osteogenetic powers, a layer of bone developed. In the management of such cases, I hold the view that *the maxillary bones which are separated should be moved in contact in very early infancy before ossification is so far advanced as to prevent bending and easily moving them into proximity. When we have placed the edges of the cleft bones in contact, we have brought the parts into their normal condition as far as the breadth of the jaw and the relation of the bones to each other is concerned.* The theory advanced that the moving of the separated bones into contact will abnormally contract the upper jaw has not been established by clinical experiences. It has been exploited by those who have supposed that the space forming the cleft is the result of arrest of development of the palatal tissues. The assumption has been that the moving of these parts together would produce an abnormally narrow arch. Such statements are theoretical. They are not based on post-operative observations.

It has been my privilege to witness the work of Lane. While he succeeds in closing the cleft, it would seem that the open fissure is covered only by the soft parts with no prospect of bony union, whereas the bringing the edges of the bone into contact, after my own method of practice, *insures the union of the plates of the hard palate, thus establishiug a substantial bony arch.*

Blair's Operation.—"The operation consists of passing silver wires through the maxillary bones from one buccoalveolar cul-de-sac to the other. By twisting the wires over two lead plates and by lateral pressure on the bones and, when needed, by cutting the outer wall of the orbit through a very small mucous incision, the anterior end of the cleft is obliterated, and the posterior part is narrowed. The parts of the maxillæ that are brought in contact should be denuded to the bone. If it is thought expedient, a muco-periosteal flap can be raised from the hard palate on both sides and united over the anterior third of the cleft. If this is to be done, the muco-periosteal flap should be freed and the sutures in this flap inserted, before the anterior parts of the maxillæ are completely approximated. The various steps of this operation are illustrated in Figs. 549 to 553.

The needle shown in Fig. 554 is held in a strong needle holder and inserted high up in the cul-de-sac, and with a little twisting motion it enters the bone without difficulty. In young infants there is no space between the tooth and the orbit, and the needle either penetrates the upper part of the tooth sac or passes along the upper surface of the floor of the orbit (Fig.

555). The latter course is often evidenced by the appearance of a subcutaneous orbital hemorrhage. We have never seen any evil effect to follow from this. The height at which the needle may be entered can be judged by noting the lower border of the orbit on the face (Fig. 555).

"Dr. Brophy uses the needle illustrated in Fig. 509, and passes it through the gum, at a lower level than described above. Though this must do some damage to the developing deciduous teeth, it cannot directly injure

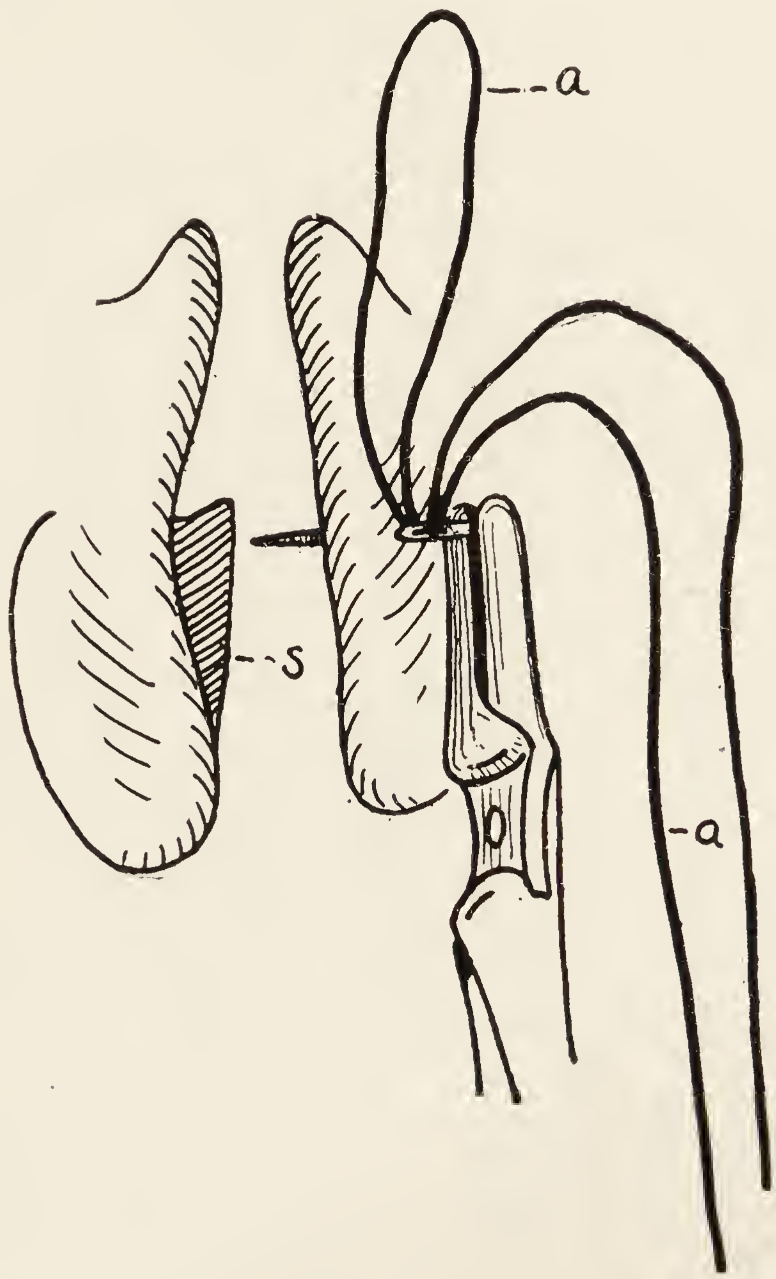


FIG. 549.—Approximating the maxillæ by through-and-through wires. First step, placing a heavy silk loop through one maxilla posteriorly. (*Blair.*)

the buds of the permanent teeth, which at this time are very small and lie to the median side of the large crowns of the teeth of the first dentition.

"The wire we use is a very soft No. 20 virgin-silver wire. A strong braided silk, or silkworm gut, should be used as carriers for drawing the wires through the bone. We believe that placing the wires above the floor of the orbit and the lead plates high up on the alveolar process has several substantial advantages. The orbit is relatively large for its contained structures, and there is plenty of room to pass the needle above the floor through the orbital fat without injuring the ocular muscles. The body of the maxillary bone is rather compact and less lacerated by the passage

of the needle and wires than is the alveolar border. Where it is desired to narrow the posterior part of the cleft, the high position of the wires and plates gives a better hold for retention. It is a surgical impossibility to bring the borders of the palate processes in contact with each other by this operation, and even in very young infants the posterior part of the cleft cannot be narrowed to any considerable degree without employing a crushing force. This can be done by covering the jaws of a pair of long sequestrum forceps, inserting them through the mucous membrane at the upper fornix of the vestibule on each side, and getting a grasp on the bodies of the maxillary

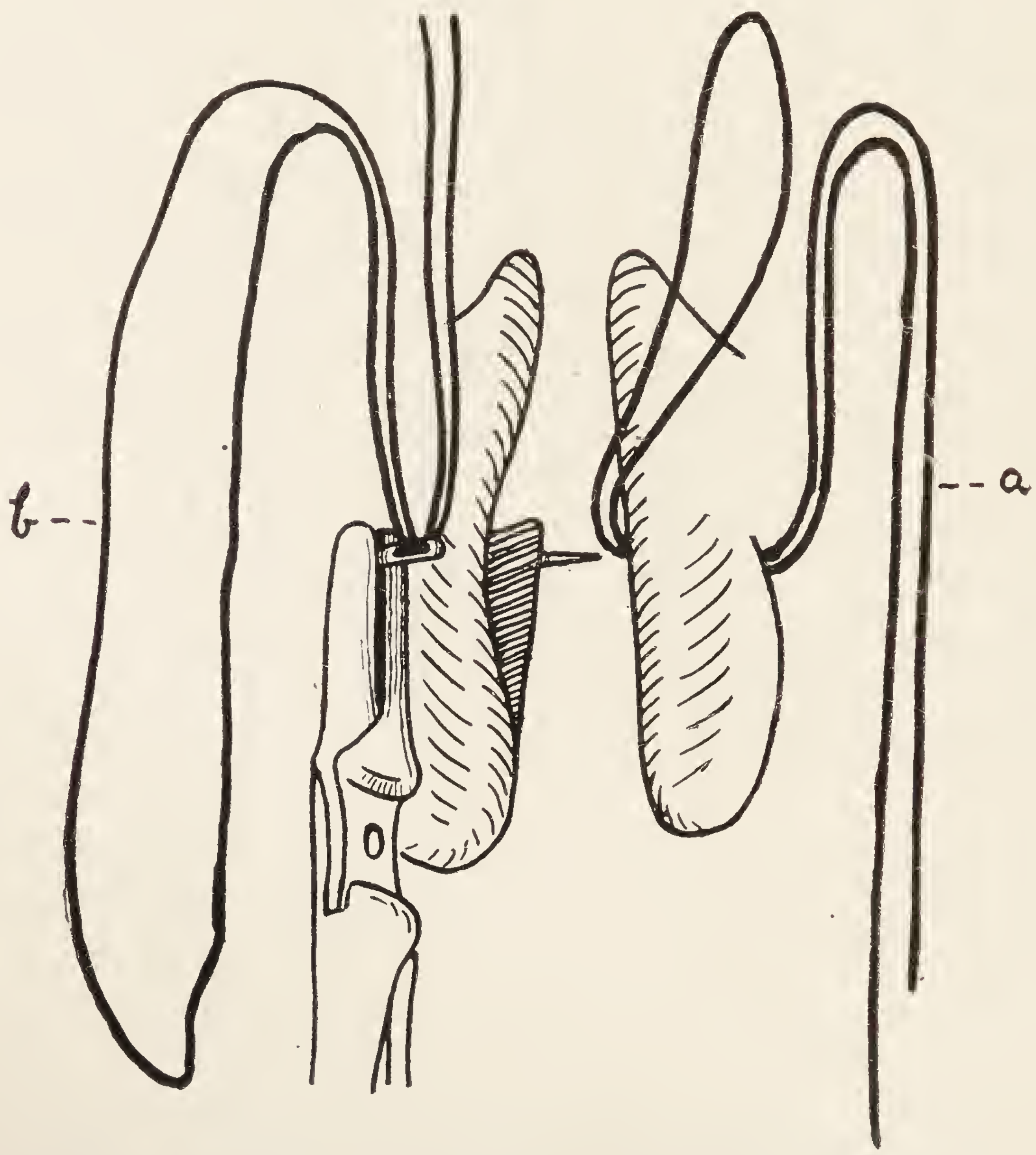


Fig. 550.—Approximating the maxillæ by through-and-through wires. Second step, placing a heavy silk loop through the other maxilla posteriorly. (*Blair.*)

bones (Figs. 556 and 557). If any pressure is exerted on the alveoli, they will fracture into the tooth sacs, and the teeth will be expelled. The borders of the anterior part of the cleft can be closed by simply pressing open the alveoli with the fingers or with the handle of a knife, and taking up the slack in the wires by twisting them on each side alternately. No attempt should be made to draw the bones together by simply twisting the wires, and both wires must share equally in the twist, otherwise one of them is apt to snap at the plate.

"With increasing observation, we are more and more inclined to simply

obliterate the anterior part of the cleft and allow the posterior portion to take care of itself until the flap operation is performed. At the age of ten months or two years, it is usually easy to close the posterior part of the cleft by a von Langenbeck operation. In the Brophy operation there is little

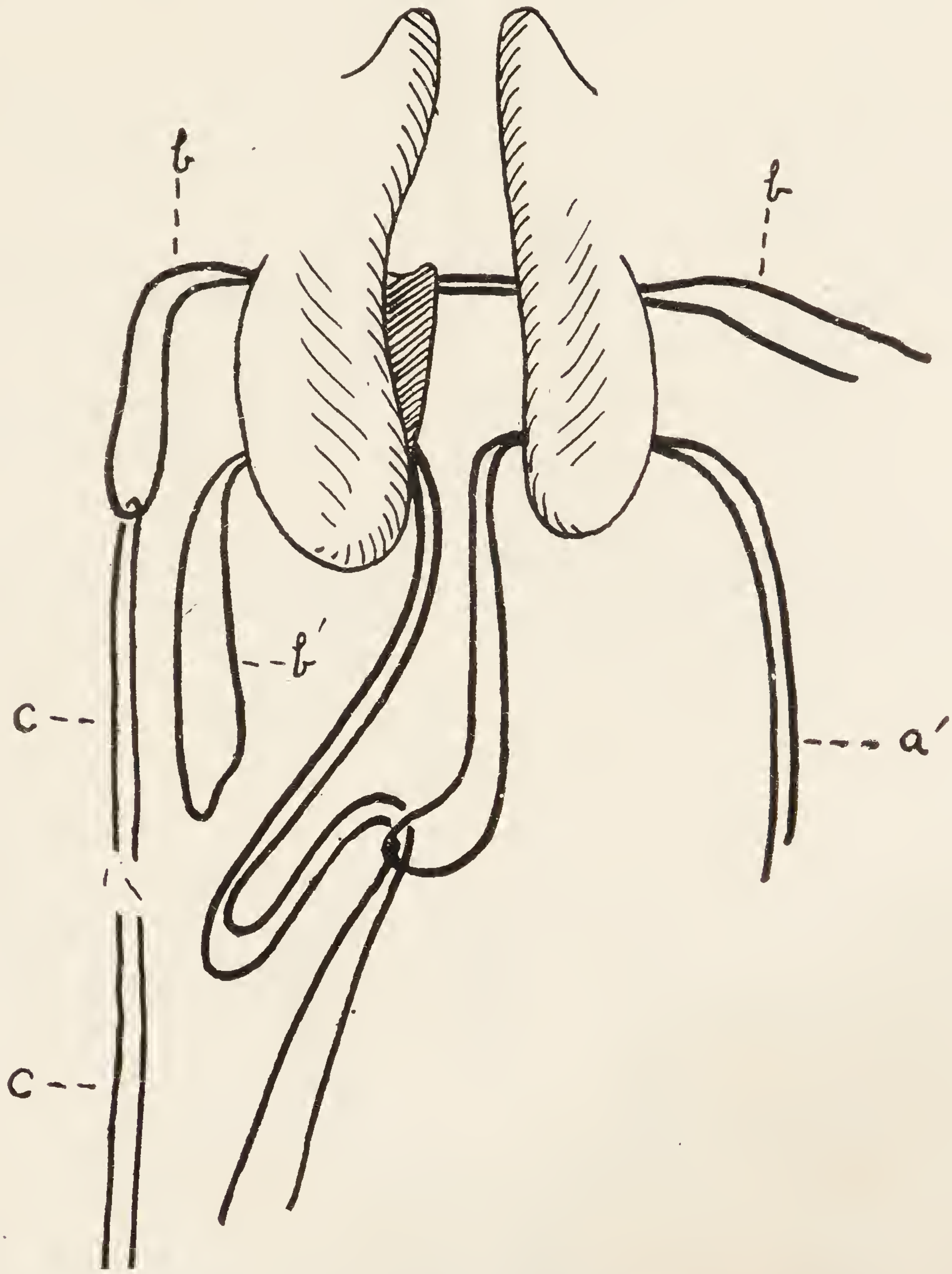


FIG. 551.—Approximating the maxillæ by through-and-through wires. Anteriorly is shown how one loop (a') is passed over the ends of the second loop (b'). By drawing on the (a') loop, the (b') loop is made to traverse both maxillæ. (b) shows loop in position with wire; (c) ready to be drawn in place. (*Blair.*)

hemorrhage, and unless too energetic efforts have been made to close the posterior part of the cleft, there is no shock.

"The objection that has been argued against this operation, that it unduly narrows the palate and the nasal passages, is not necessarily true; for the maxillary bones are already spread apart, and the operation attempts simply to restore them to the natural position. However, it is very easy in some cases to carry the operation to the extent of obstructing the anterior part of the nasal fossa and cause nasal obstruction on one or both sides. This

point should be carefully watched, and each nasal fossa should, in a young infant, admit a probe with a head 2 or 3 millimeters in diameter. The

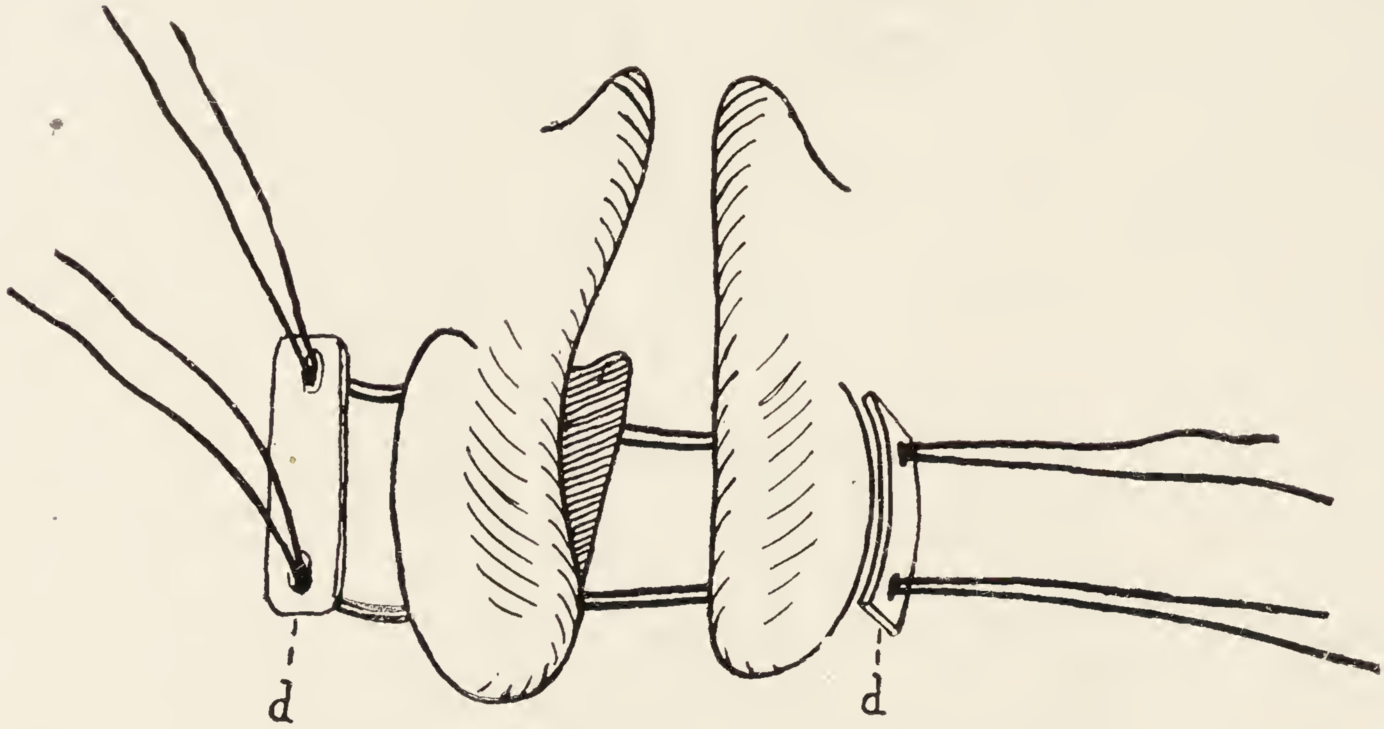


FIG. 552.—Approximation of the maxillæ by through-and-through wires. Showing two double wires in position threaded at each end on a lead plate (*d*). If single wires are used, No. 20 is the proper size, while No. 22 or 24 is used double. (*Blair.*)

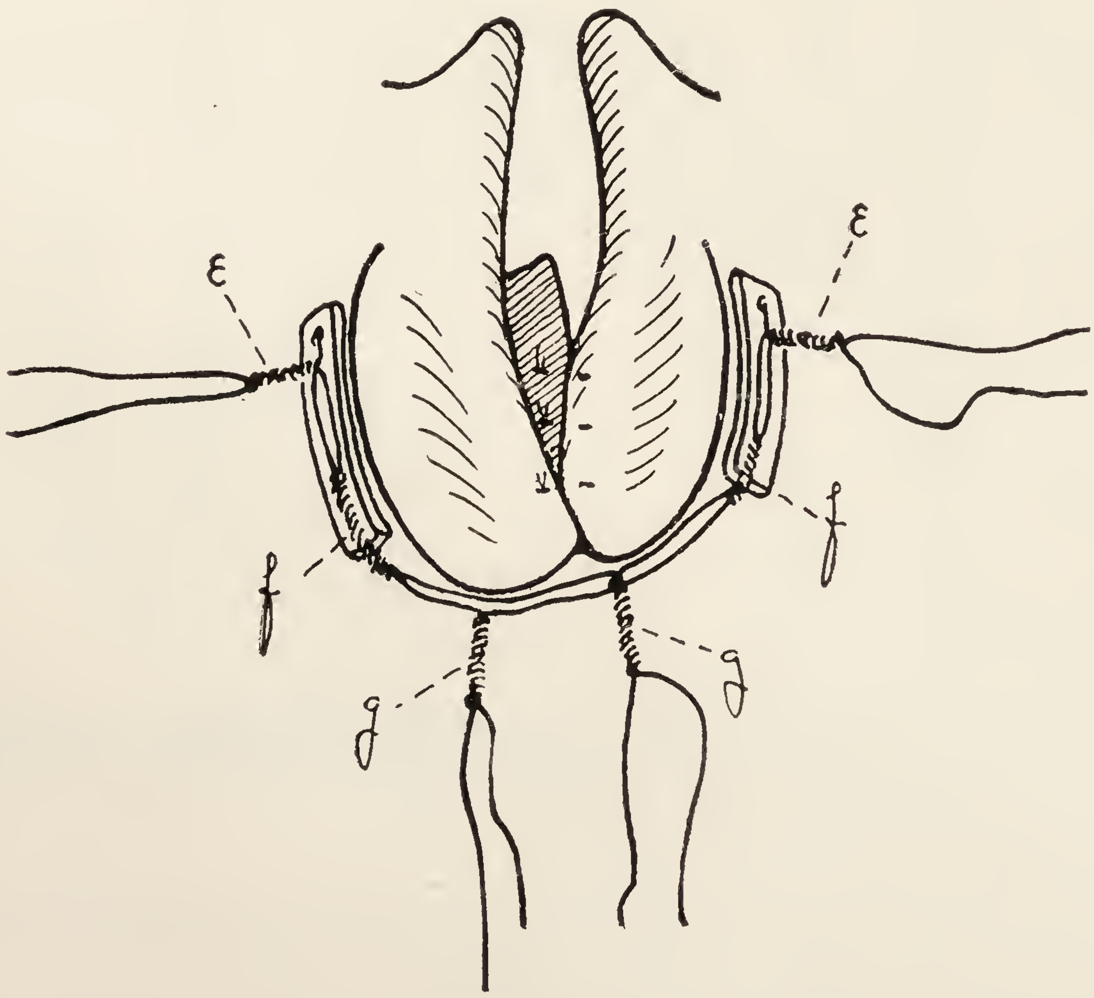


FIG. 553.—Approximation of the maxillæ by through-and-through wires. This shows the maxillæ approximated. This is done by pressing the bones together and taking up the slack by twisting appropriate wires. The approximation of the alveolar part of the cleft is made more sure by bringing two of the wires around the intermaxillary bone and twisting them at (*g*, *g*). (*Blair.*)

deciduous teeth are usually lost soon after the operation; but this often happens in cleft palate cases where no operating has been done, and is a

FIG. 554.—The needle used in piercing the maxillæ is known as a ⅝-circle, reverse-eyed Hagedorn. Two sizes are used: one a circle the size of a nickel, the other the size of a quarter. Some of the broad cutting point is ground off. (*Blair.*)

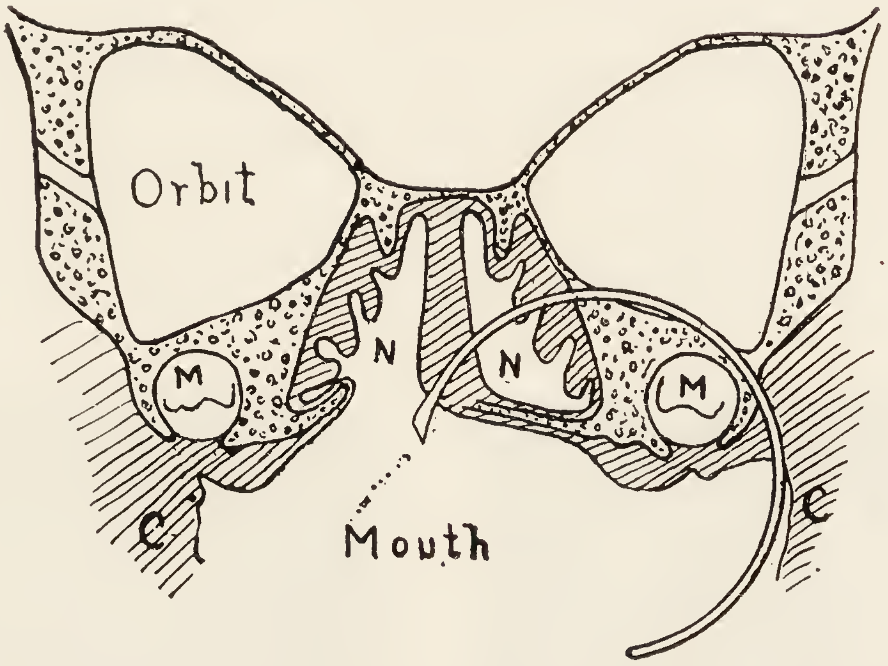


FIG. 555.—An accurate diagrammatic reproduction of a section of a frozen head of an infant with a single cleft of the palate. This illustrates how a ⅝-circle needle can be made to pass from the upper buccal fornix, through the jaw-bone, along the floor of the orbit and into the cleft. (*Blair.*)

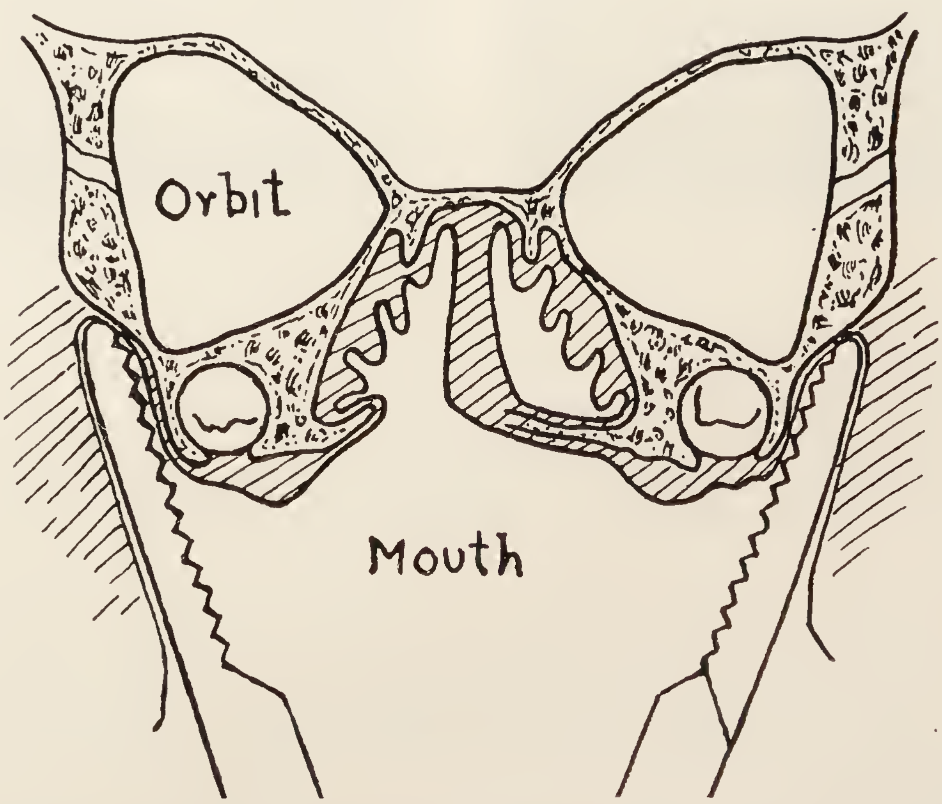


FIG. 556.—Showing position of the jaws of the forceps in forceful approximation of the maxillæ. (*Blair.*)

minor consideration. In doing the operation, Dr. Brophy draws two wires through each hole in the bones, principally to have a reserve in case one wire breaks. If a soft No. 20 wire is used, and the wires are twisted only to take up the slack that is gained by pushing the maxillæ together, there will be no danger of their breaking short. The prominent intermaxillary

FIG. 557.—Double-edged knife, occasionally used in cutting the maxillæ. It is thrust high into the body of the bone, through a small opening in the mucous membrane, and moved forward and backward in the bone. (*Blair.*)

part of the alveolus can be held back, either by twisting two of the long ends of the wires around the front of the gum (Fig. 553) or by passing a separate finer wire through the alveolus on each side of the cleft. If the needle pierces the alveolar process of the intermaxillary bone, it should be in the midline. By doing this, injury to the buds of the permanent central

FIG. 558.

FIG. 559.

FIG. 558.—Wide single cleft in a very young infant. Result of the Brophy operation shown in next figure.

FIG. 559.—Shows the result that may be obtained by the Brophy operation, in a very young infant. In doing this, the nasal passages should not be obstructed. Although this infant did well in every way, still drawing together the maxillæ to the extent here shown may produce nasal obstruction. (*Blair.*)

incisors will be avoided. In either case it is better to pass the wire through the fraenum and make the twist at one side, as this places the wire higher on the bone. The twisted ends should be cut short and bent so as not to stick into the cheeks.

"The operation illustrated above is the one we performed for a number

of years on every wide complete cleft in an infant under three months (Figs. 558 and 559). Of late we have been satisfied, in very young infants with single clefts, to forcefully approximate the maxillæ and pass one wire through the anterior part of the jaws, bringing it around in front of the intermaxillary bone without the lead plates. This is a simpler operation, and we believe here that the results are equally satisfactory.

"The closure of the posterior part of the palate and velum is done later by the ordinary flap-sliding operation at any time between the sixth and eighteenth month, or even later. It is easier to do it at a year or eighteen months than at an early period. It should be done before the end of the second year. The health of the child, the season, and the state of dentition are all to be considered."

POST-OPERATIVE TREATMENT

Washing the Stomach.—During the operation mucus, saliva and blood will be swallowed by the patient. It is too apparent to require comment that the accumulation of saliva, mucus and blood, in the form in which they mix in the stomach, would cause a general disturbance of the alimentary canal. Immediately following the operation, I have found it advantageous to irrigate the stomach and wash away its entire contents. To do this, the patient's head should be inclined backward considerably. A stomach tube of suitable size, lubricated with vaseline so it will pass readily, should be introduced. At the outer end a funnel is fixed and warmed water poured into the stomach until no more can be admitted. Then the patient is turned over upon his face, the feet elevated, the funnel quickly lowered and the contents of the stomach siphoned out. This may be repeated two or three times until the fluid of the stomach comes away clear. In young children, a large sized catheter, No. 26 F., will serve the purpose very well. I have found that in young children the temperature does not rise so high, following washing of the stomach, as in cases where this precaution has not been observed.

Watching Patient Essential.—After the stomach has been irrigated and its contents removed, the patient should be wrapped warmly before leaving the operating room and carried quickly to his bed, where hot water bottles should be placed at the back and feet, caution being observed to avoid burning from overheated bottles. With the patient on one side, the tongue is not so likely to fall back into the pharynx and interfere with respiration. The nurse should be in constant attendance until the patient has recovered from the effects of the anesthetic lest difficult respiration or circulation should require the services of the interne, who should always be within call.

Preventing Infection.—Realizing that the mouth and nose are great centers of infection, the management of a palate, following the operation, must receive careful attention. In describing the preparation of the patient, it

will be remembered that frequent irrigation of the nose and mouth was recommended, with a view to freeing the field of operation, as far as possible, from pathogenic micro-organisms. Following an operation, the same care should be exercised, to prevent infection and destruction of the approximated tissues which we are endeavoring to unite. Great responsibility, therefore, falls upon the interne and the nurses in charge in carrying out antiseptic methods. A systematic course of irrigation should be employed, the nose and mouth being irrigated at least three times a day with boric acid or normal salt solution. A fountain syringe may be employed for this purpose, the point of the syringe being carried into the nose while the patient is so posed that the fluid will escape through the mouth. The patient will not be so likely to swallow the fluid. Dr. Woolley's metal point rubber bulb syringe is so constructed that a fine spray may be directed against the surfaces of the palate with considerable force as well as through the nose (Fig. 532). This spray will thoroughly remove the secretions that accumulate upon the membranes. The soft rubber bulb ear syringe also serves the purpose very well. If the mucus and saliva become thick and ropy and seem to cling tenaciously to the palate or nose, they may be more effectually removed by making use of a little alcohol added to the boric acid solution (a dram to one pint). This will cut away the mucus and leave the surfaces free and clean.

The spraying of the nose with a twenty per cent. solution of argyrol is an excellent prophylactic. Touching the line of union on the lingual aspect of the palate with a twenty per cent. solution of argyrol serves as a preventive of infection. Particles of food and incrusted mucus, which may collect about the plates, should be thoroughly removed. The patient should be given only liquid food for the first five or six days following operation. A month or two after an operation for cleft of the velum, the soft palate may be benefited by gentle massage. This will stimulate the circulation and give a greater degree of flexibility.

When Infection Occurs.—Should infection of the parts occur, unfortunately, and the application of the twenty per cent. solution of argyrol fail to destroy the pathogenic micro-organisms and arrest the destructive process, the surfaces should be painted with tincture of iodin. I have found iodin the most potent of germicides and I rely upon it to arrest infection when all other agents fail. Under no circumstances whatever should hydrogen peroxide be used as an irrigant or as a local application. When the oxygen is liberated, the line of sutures will be torn out and the parts separated thus destroying the work. It has never occurred in my experience that the tissues have become necrotic or sloughed following the early operations of moving the bones together. Happily, these bones are richly supplied with blood and the nutrition is, therefore, abundant to establish the process of repair and preserve within all the tissues a liberal circulation.

SECONDARY OPERATIONS ON THE PALATE

The most successful operators sometimes meet with failure in securing a union of the divided parts (Figs. 560 to 563). This failure may be partial or complete. The surgeon approximates the freshened edges of the fissure and, by the use of lead plates, holds the parts in quiet contact. With these plates, previously described and illustrated, he is able to maintain an approximation of the edges of the cleft, but the work of Nature cannot always be relied upon to effect the process of repair. The question resolves itself

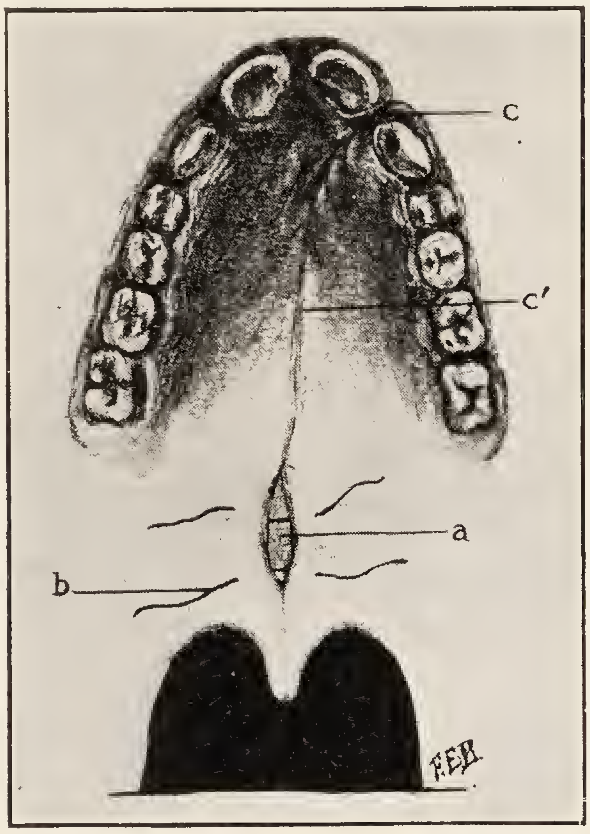


FIG. 560.—*a*, Partial non-union of soft palate following repair; edges denuded. *b*, Silver wire in situ. *c*, *c′*, Line of approximation of segments of hard palate obtained by previous operation.

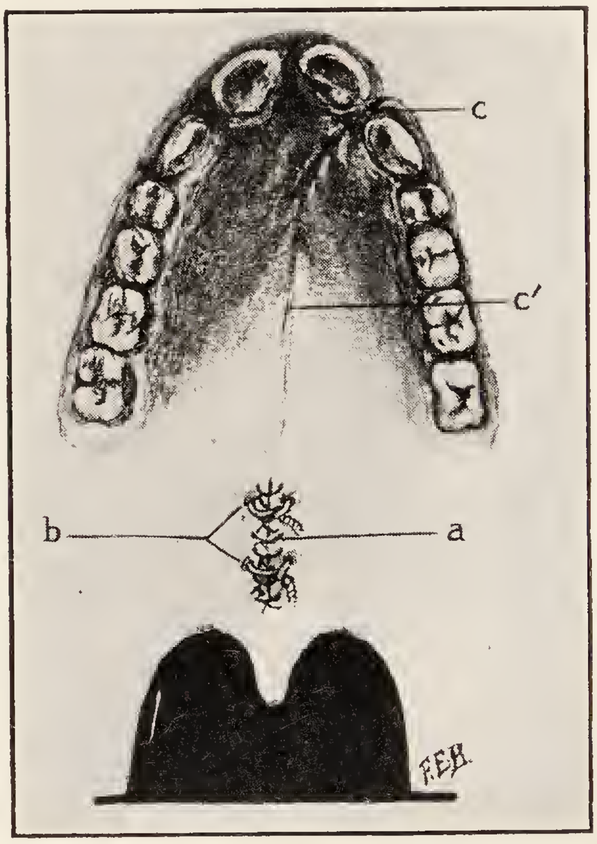


FIG. 561.—*a*, Small opening in soft palate closed by horse-hair sutures after denudation of margins. *b*, silver wire retention sutures twisted in position. *C*, cleft of hard palate closed at previous operation.

into the behavior of wounds. The experienced surgeon realizes fully that in a wound immediate repair does not always take place. In some patients the repair of a wound is tardy, while in others the lips of the wound, though in contact, remain ununited for a considerable length of time and may refuse to heal. Such is the case occasionally in the closing of a cleft palate. The general condition of the patient is oftentimes responsible for partial or complete failure of union following these operations. The patient's physical condition, as has been stated, should be considered carefully prior to any operation.

When to Re-operate.—If either partial or complete failure of union of the palate follows an operation, it would be extremely unwise to operate again until after sufficient time has elapsed to enable the tissues to fully recover from the effects of the first operation. If there is failure of union throughout

the entire length of the palate, from three to six months should be allowed to pass before another operation is attempted, when it will be necessary to repeat the first operation with such modifications as the condition of the parts may require. Among some of the most difficult operations on cleft palates are those following failure of union or the breaking down of tissues. As a result of making lateral incisions through the soft parts, a great mass of cicatricial tissue is sometimes encountered, the circulation of which is poor, and the union of the edges following freshening and suturing is thereby rendered far more uncertain than it was at the first operation.

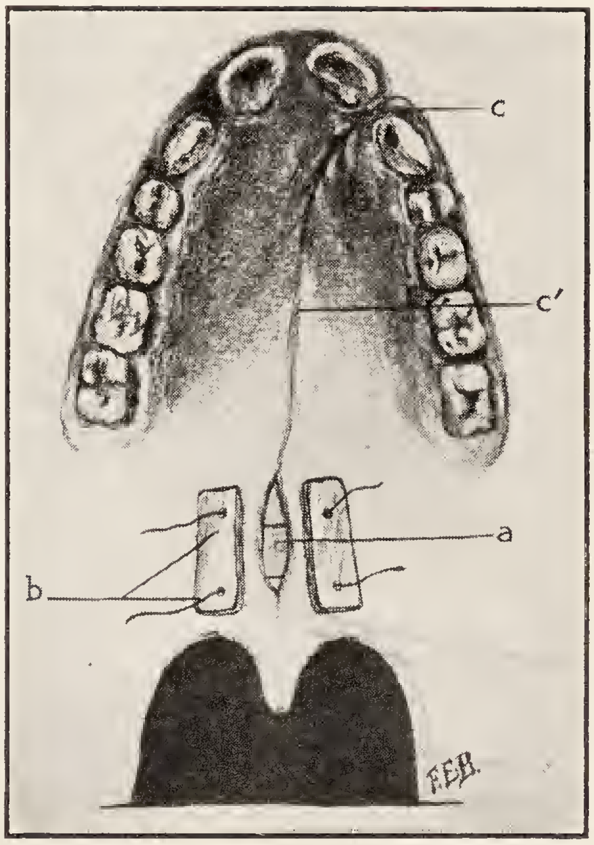


FIG. 562.—*a*, Partial non-union of soft palate following repair; edges denuded. *b*, Lead plates and silver wire in position showing relation to opening. *c*, Cleft of hard palate closed by previous operation.

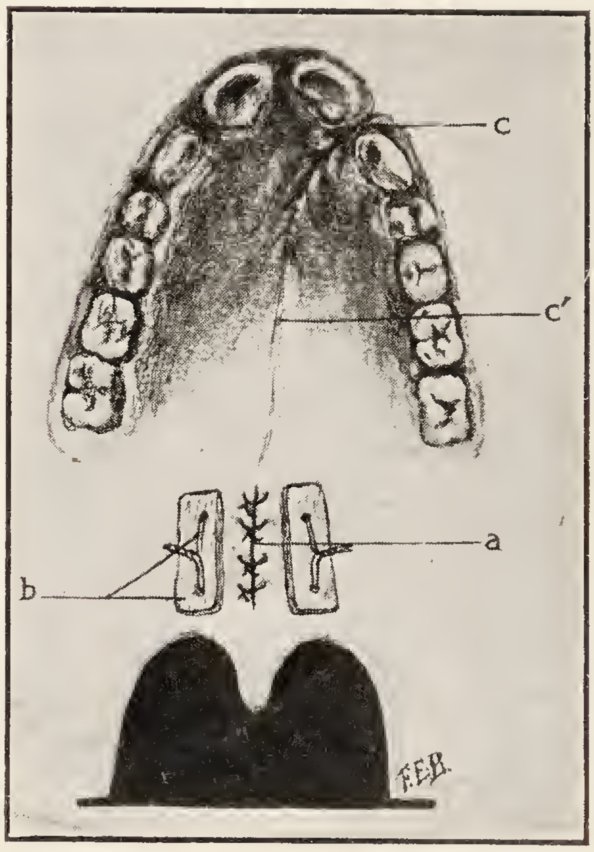


FIG. 563.—*a*, Opening in soft palate closed by horse-hair sutures after denudation of margins. *b*, Lead plates with silver wire sutures twisted to maintain approximation without tension. *c*, Cleft of the hard palate closed by previous operation.

Repairing Small Openings.—In my earlier experience, if a small opening remained, I attempted, as soon as it was discovered, to close it by suturing—in most cases to my regret. If a small opening follows, the young surgeon is strongly inclined to attempt its closure before the tissues have recovered from the previous operation. I am satisfied such attempts, when the tissues are still congested, are not justifiable. Several weeks, or even months, should be allowed for the parts to recover their normal circulation and tonicity. A hole in the palate may vary from the size of a small sinus, which will admit only a small silver probe, to an opening as wide as the palate. The closing of a hole of this character may be accomplished in two ways, the methods to be employed depending largely upon the size and character of the opening. If a small opening occurs in the soft palate it may be closed by suturing with

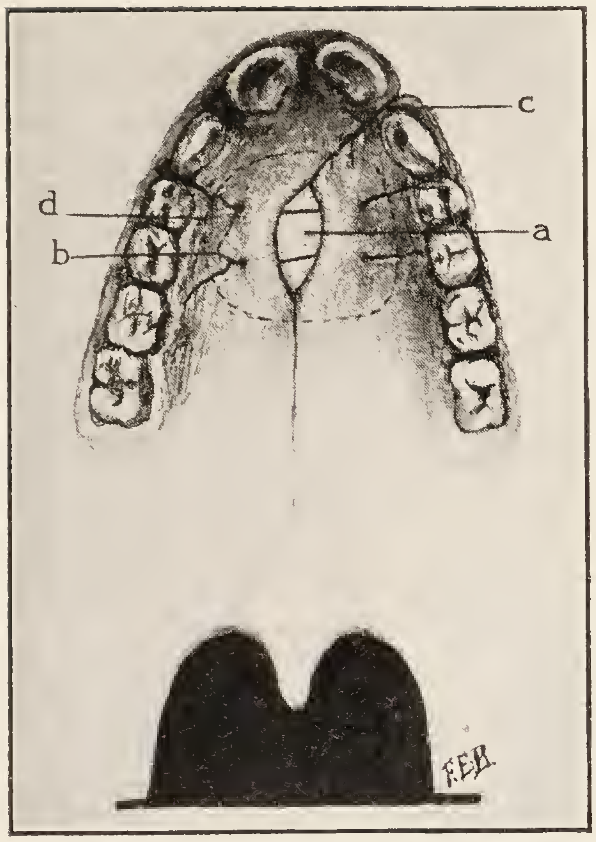


FIG. 564.

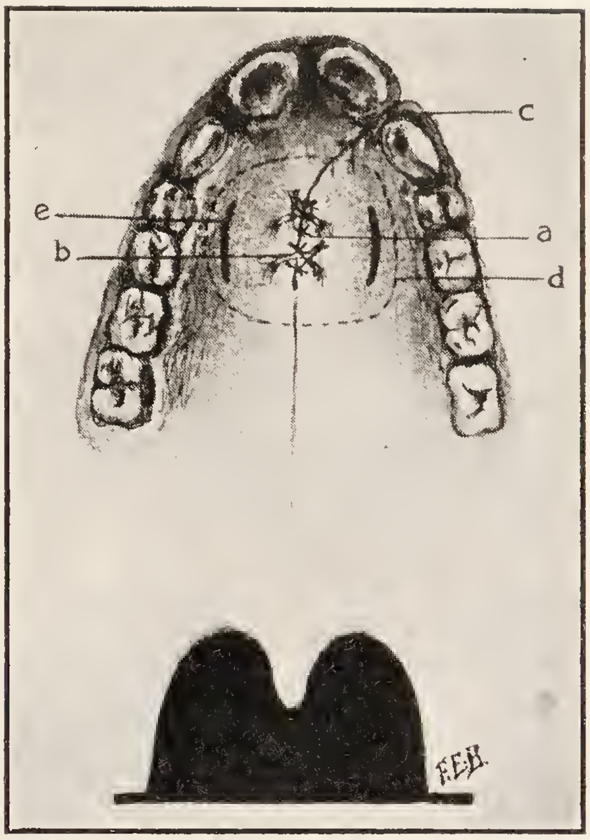


FIG. 565.

FIG. 564.—*a*, Opening in hard palate. *b*, Silver wire retention sutures in place. *d*, Area of periosteum elevated from the bone to prevent tension.

FIG. 565.—*a*, Opening in hard palate closed by horse-hair sutures following denudation of margins. *b*, Silver wire retention sutures twisted. *c*, Approximation of alveolar processes obtained by previous operation. *d*, Dotted line indicates area of soft parts and periosteum elevated to permit margins of opening to be approximated with least degree of tension. *e*, Indicates incisions through soft tissues; to be employed when tension warrants, further explained by Fig. 568.

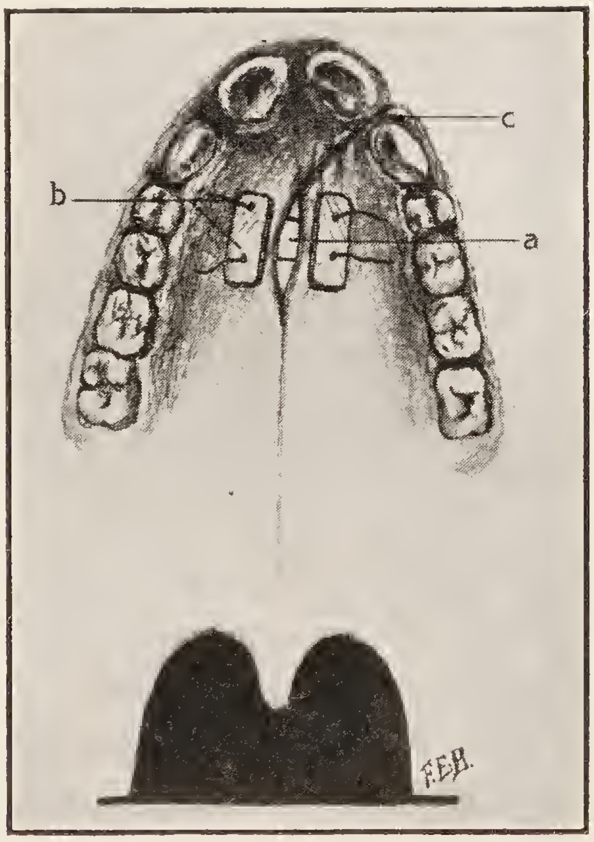


FIG. 566.

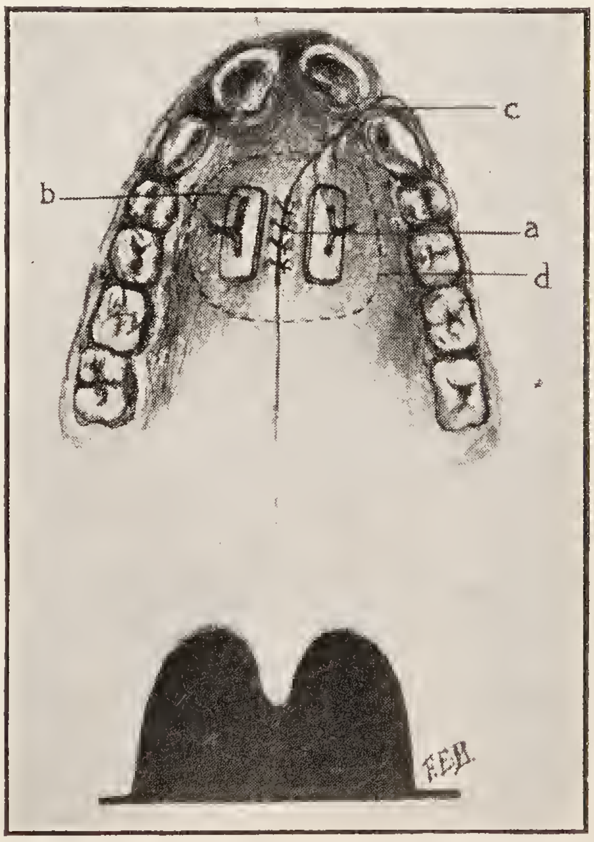
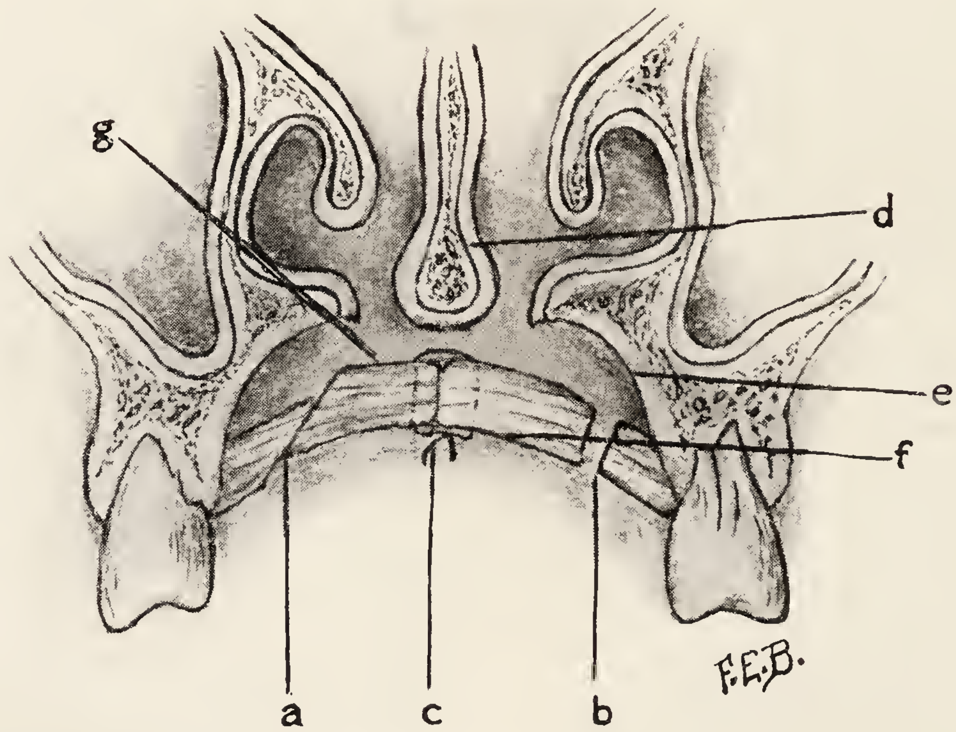


FIG. 567.

FIG. 566.—*a*, Opening in hard palate following repair, edges denuded. *b*, Silver wire and lead plates in position. *c*, Approximation of alveolar processes obtained by previous operation.

FIG. 567.—*a*, Opening in hard palate closed by horse-hair suture. *b*, Lead plates in position and silver wire retention sutures twisted. *c*, Approximation of alveolar processes obtained by previous operation. *d*, Dotted line indicates area of soft parts and periosteum elevated to prevent tension. Incisions may be employed as in Fig. 565 if tension persists.

horse-hair or silver wire; if the opening is of larger size in the soft parts, silver wire with lead plates may be used to secure tension upon the tissues (Figs. 560 to 563). If small openings occur in the bone, the muco-periosteum should be raised with the periosteal elevators, the edges freshened and the parts sutured. The raising of the muco-periosteum will drop these parts low enough, oftentimes, to enable the freshened edges to be brought directly together without incisions (Figs. 564 to 567). If, however, the edges will not meet, oblique incisions are made to the bone close to the teeth which allows the edges of the opening to meet.



Sagittal Section

Fig. 568.—Sagittal section illustrating the technic of closing a large hole in the hard palate. The muco-periosteum has been lifted from the bone. *a*, Correct method of making incision through the soft parts. The incision is started near the border of the teeth and carried obliquely upward so that a large part of the freshened surfaces may be kept in contact. *b*, Incorrect incision. An incision made straight through the membranes is followed by separation of the soft tissues, thus retarding healing and sometimes results in failure of union. *c*, The opening closed by wire sutures. *d*, Vomer. *e*, Palatal process of the maxilla. *f*, Mucous surface. *g*, Periosteal surface. The artist should have made the incisions a little closer to the teeth, so as to avoid the blood vessels.

Repairing Large Openings in the Hard Palate.—In larger openings it becomes necessary to move the soft parts farther than their attachments will permit. There are two methods by which this opening may be closed:

First, by lifting the muco-periosteum from the bone, freshening the edges of the opening and introducing silver wire sutures, which are twisted so as to bring the edges of the opening into as close proximity as possible. After this, incisions are made very close to the teeth and the muco-periosteum moved toward the median line by further twisting the wire sutures. Thus the edges can be brought into contact. These incisions should be so made that the bone will not be entirely denuded of periosteum, as would be the case if the knife were carried straight through it. This can be obviated

by making an oblique incision which starts close to the alveolar margin, carrying the incision upward and inward so as to bring the edge of the knife to the bone about one-fourth of an inch medially from the point of entrance (Fig. 568). It will be seen that the freshened surface of connective tissue on both sides of the incision will unite and close the aperture. The openings made by the side of the teeth should be lightly packed with iodoform gauze so as to prevent the passage of air and to promote the formation of granulation tissue along the line of incisions. The incisions made through the muco-periosteum at the border of the alveolar processes leave openings which will soon close by the formation of granulation tissue and the palate at this particular location will not be impaired.

Fig. 569.—Drawing from plaster cast showing a large opening in the hard palate in a young child, the result of failure to secure a union following cleft palate operation.

It must not be understood that these incisions are not in accord with my statements regarding incisions in the soft parts for the division of the tensor palati muscle in operating on the palate. The division of the tensor palati muscle, in my opinion, is not called for in any palate operation, with, perhaps, some rare exceptions. Its division does impair the function of the palate and of hearing, but the division of part of the muco-periosteum covering the hard palate cannot result in any injury since the hard palate is a solid, immovable arch and the formation of cicatricial tissue over its surfaces, therefore, does not interfere in any way with its function.

When large openings or holes remain in the hard palate in children following operation (Fig. 569), owing to failure of union, I have frequently extracted the upper deciduous molars on each side (Fig. 570). I have done this in children prior to the eruption of the first permanent molar teeth, which occurs about the sixth year. It is essential to wait until the sockets of the

teeth have perfectly closed, a period of something like six months. Then an incision is made through the muco-periosteum, beginning at the palatal surface of the cuspid tooth, carrying the incision across the alveolar process,

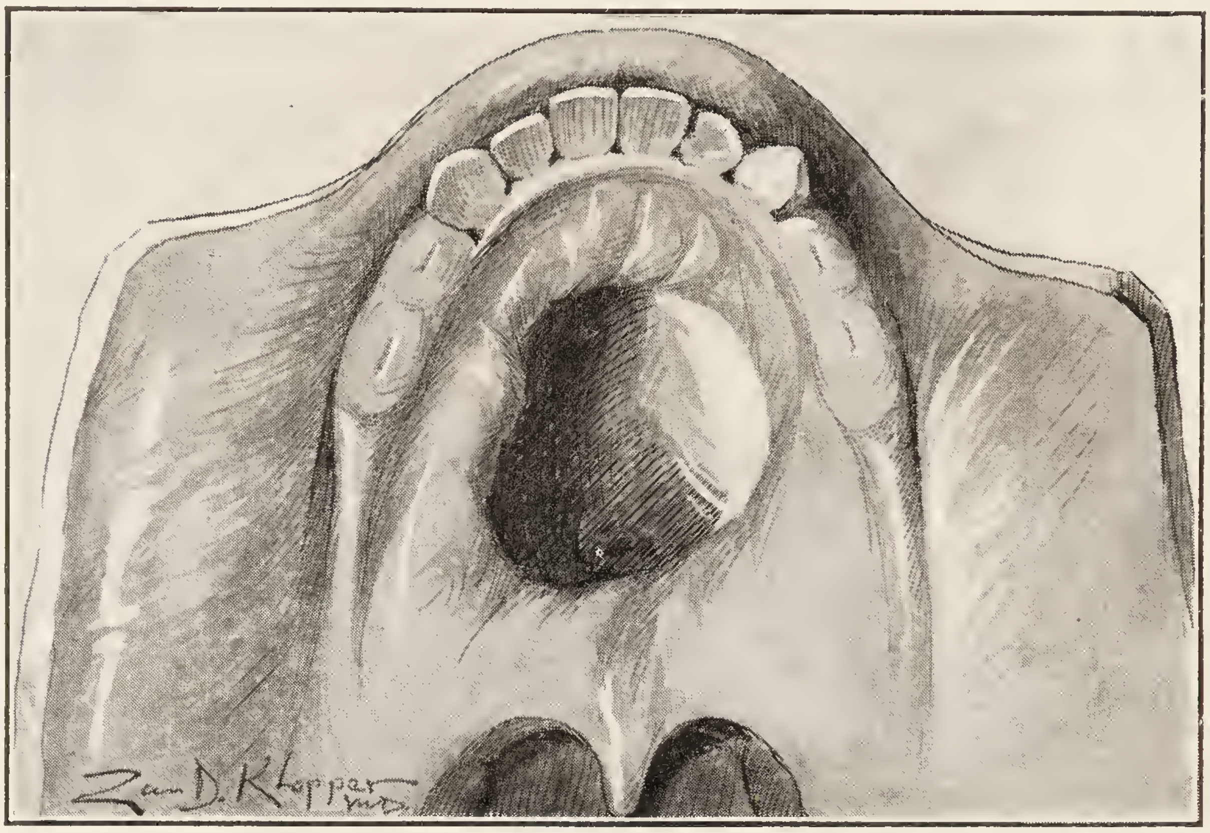


Fig. 570.—Deciduous molar teeth removed so as to provide for the making of flaps to close the opening.

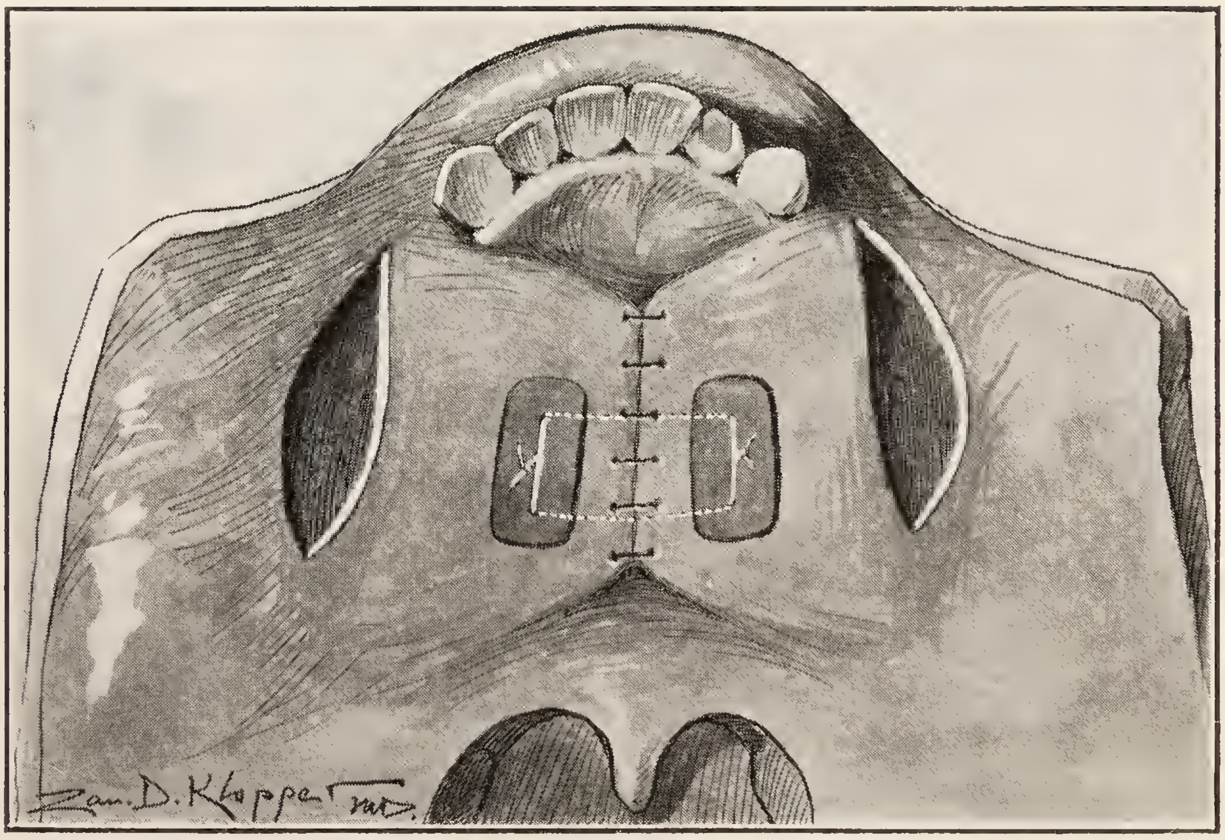


Fig. 571.—Flaps made and opening closed. New openings will fill in with granulation tissue.

upward over the external alveolar plate and up upon the buccal mucous membrane, backward beyond the tuberosity of the jaw and then inward toward the soft palate. This incision is made deep enough into the tissues

of the cheek to enable the operator to carry away considerable of the muscular tissue. The parts are dissected away from the bone and we thus get a great quantity of tissue with which to close the opening (Fig. 571). The loss of the deciduous upper molar teeth, between the age of five and six years, is always to be regretted, but the removal of the deformity of the palate renders the procedure justifiable. It is needless to state that we would not remove these teeth except as a last resort.

Repairing Very Large Opening.—*Second.* The majority of the post-operative openings of the hard palate, I regret to state, are not infrequently due to the methods still practised, namely, the chiseling of the bone and moving the palatal plates of the bones toward the median line

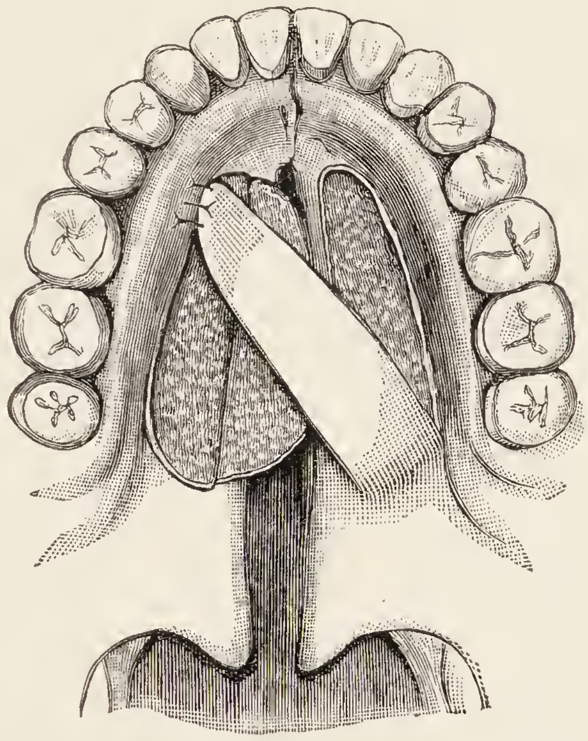


Fig. 572.—Davis Colley Method. Flaps in position. (*Bryant's Operative Surgery, Copyright by D. Appleton & Co., New York.*)

for the purpose of approximating them and thus closing the cleft. The bones thus separated sometimes become necrotic, slough out and leave enormous openings in the palate. In other cases, the openings are due only to the failure of the tissues to unite following previous operations. In speaking of methods of dividing the bones according to Dieffenbach and Fergusson, Bryant comments thus: "Differences of opinion exist among competent authorities regarding the wisdom of this plan of practice, it being claimed that hemorrhage, sloughing, necrosis and septicemia are quite prominent factors in its history, especially in children of lessened vigor."

The second method is to make use of flaps from the muco-periosteum carrying them over the opening and securing them there by suturing by the Davies-Colley method. This consists in the making of a long, triangular shaped flap, extending from a point just posterior to the incisor teeth and sufficiently back to avoid the division of the palatine artery. The base of the triangle extends as far back as the tuberosity of the maxillæ. The breadth of the flap extends from the border of the alveolar process almost to the border

of the cleft. Another flap is made by an incision along the alveolar border of the opposite side, or at the other side of the cleft. The inner border of the flap is continuous with the soft parts at the edge of the cleft. Beginning at the alveolar incision, the flap is raised from the bone and turned, hinge-like, over across the cleft. This flap is turned in such a fashion that the freshened surface comes in contact with the freshened surface of the flap first made, being secured in the position by means of sutures. The flaps thus crossed (Fig. 572) are sutured together, forming a bridge over the hole. The hole is thus closed, with little hemorrhage and with a reasonable assurance of success.

ADVANTAGES OF THE USE OF LEAD PLATES AND SILVER WIRE SUTURES

First.—The sutures do not cut out, since the lead plates extend the whole length of the cleft of the soft palate and, as the wires are tightened, the plates make tension on the entire length of the soft parts. The holding of the edges of the fissure in contact, therefore, is not by the sutures alone, which exert pressure on so limited a portion of the tissues, but by the lead plates.

Second.—The lead plates serve as a splint, rendering the palate inflexible to a very great extent. The movements, which are almost constant, are very largely suspended. The active muscles are put out of use until the edges of the cleft unite. The twisted wires bent down over the plates furnish a most excellent protection of the palate, as they are uncomfortable to the touch of the tongue, yet do not lacerate nor abrade it. The contact of the tongue is not pleasant and this is very fortunate because the patient will keep the tongue away from the palate and allow it to heal without being disturbed. I regard the adjustment of devices in the form of artificial palates and the like, as a means of protection to the sutures, as clumsy, unclean and wholly unnecessary. Having first devised lead plates as a means of approximating and holding the borders of the cleft in quiet contact, I am confident that better results can be secured by their use than by the employment of sutures alone.

Third.—With the silver sutures and lead plates in position, with the edges of the cleft approximated with hair sutures, we at once see that *for the purpose of relieving tension, the making of lateral incisions through the tensor palati or any of the other palatal muscles, with all the resulting permanent injuries, is not necessary.*

Myotomy Unnecessary.—The myotomy method of operating was devised in 1844 by Sir William Fergusson of London. He recognized that the tension on the sutures was frequently followed by their cutting out and consequent failure of the approximated tissues to unite. To relieve this tension, Fergusson resorted to myotomy: dividing the levator palati, the palato-glossal and palato-pharyngeal muscles. It was found that Fergusson's operation was not so frequently followed by the sutures cut-

ting out and, consequently, it became popular. Sixteen years later, in 1860, Dr. Agnew of Philadelphia, pointed out that the action of the tensor

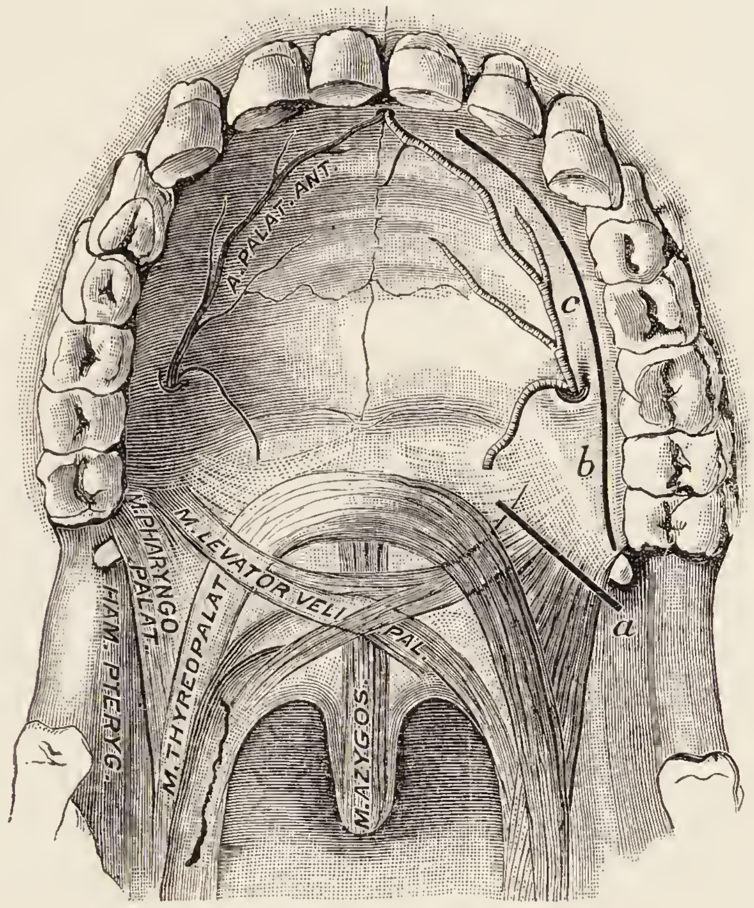


FIG. 573.—Muscles of the soft palate. *a*, Line of division of muscles. *b*, Line of incision. *c*, Palatine vessels. (*Bryant.*)

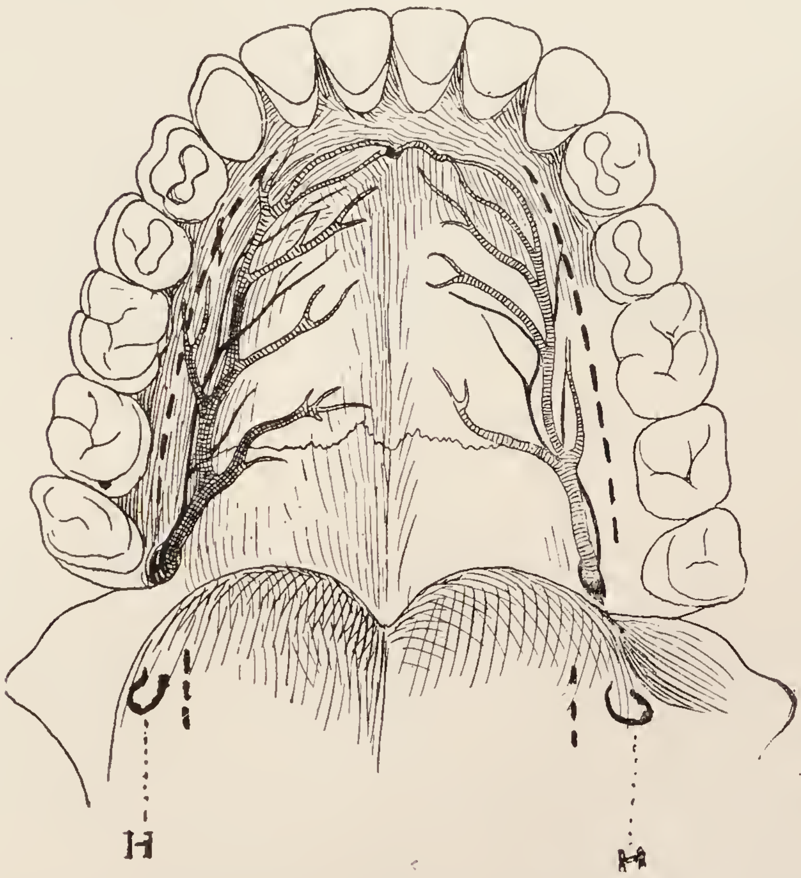


FIG. 574.—Showing the distribution of the posterior palatine and its anastomosis with the anterior palatine artery. The dotted lines show where incisions are made in closing large holes in the hard palate. (*Source unknown.*)

palati drew the newly approximated surfaces of the soft palate apart, causing the sutures to cut out and consequent failure of the operation. To relieve this

tension, Dr. Agnew divided these muscles at their constricted parts, as they passed over the hamular process of the sphenoid bone, thus relaxing the tension upon the soft palate and causing the sutures to cut out less frequently (Fig. 573). While the efforts of the distinguished surgeons named made it possible to avoid many of the failures resulting from the sutures cutting out and the edges of the segments separating, a clinical experience extending over many years and a study of the palates of patients so treated[1] *convinces me that myotomy is not only unnecessary, but positively detrimental.*

NINE REASONS WHY LATERAL INCISIONS THROUGH THE SOFT PARTS SHOULD NOT BE MADE AND THE MUSCLES OF THE PALATE DIVIDED

Operations for the closure of the soft palate (staphylorrhaphy) should be performed in such a way as to leave the tissues in the most favorable condition for the performance of their normal functions. The surgeon must keep in mind the importance of producing for the patient not only a surgical success in bringing the divided tissues in contact and uniting them, but he must do his work in such a manner as to leave the parts, as far as possible, free from permanent defects so that his patient may acquire normal speech. To do this, *the surgeon must not resort to myotomy nor the making of lateral incisions in the soft parts, for the following reasons:*

1. The tensor palati muscle arises from the scaphoid fossa of the sphenoid bone and the cartilaginous portion of the Eustachian tube. It is directed downward, then reflected over the hamular process and passes forward to be inserted into the anterior surface of the soft palate (Fig. 575). The action of the tensor palati muscle is to render the soft palate tense and to dilate the pharyngeal orifice of the Eustachian tube. The division of this muscle, as it passes over the hamular process of the sphenoid bone, causes unnecessary hemorrhage.

2. The wound creates a new field for infection and the tissues are more likely to break down.

3. Once completely divided where it crosses the hamular process of the sphenoid bone, the muscle retracts to such an extent that it is never reunited, consequently the palate loses the function of one of its most important parts.

4. It must have been observed by all operators of considerable experience that when the tension of the palate is relieved by dividing the tensor palati muscle, defective hearing follows. This is due to the destruction of the continuity of the tensor palati muscles and consequent failure of the pharyngeal opening of the Eustachian tube to dilate normally.

5. In making these uncalled-for lateral incisions, the principal branch of the posterior palatine artery is frequently divided and the palate is, therefore, deprived of its chief source of nutrition.

[1] See Figs. 433, 439, 440 and 442.

6. The lateral incisions cut off the nerve supply and muscular atrophy frequently follows.

7. Following the incision, a mass of cicatricial tissue will be formed and a thick, clumsy palate be left instead of one which is flexible and resilient. Besides, with cicatrization there will be contraction and, consequently, defective speech.

8. The operator, who makes lateral incisions, usually draws the soft palate forward and upwards in order to close the cleft, and by so doing the palate is made so short that correct phonation is impossible. Subsequently the shortening is increased by the contraction which takes place in the cicatricial

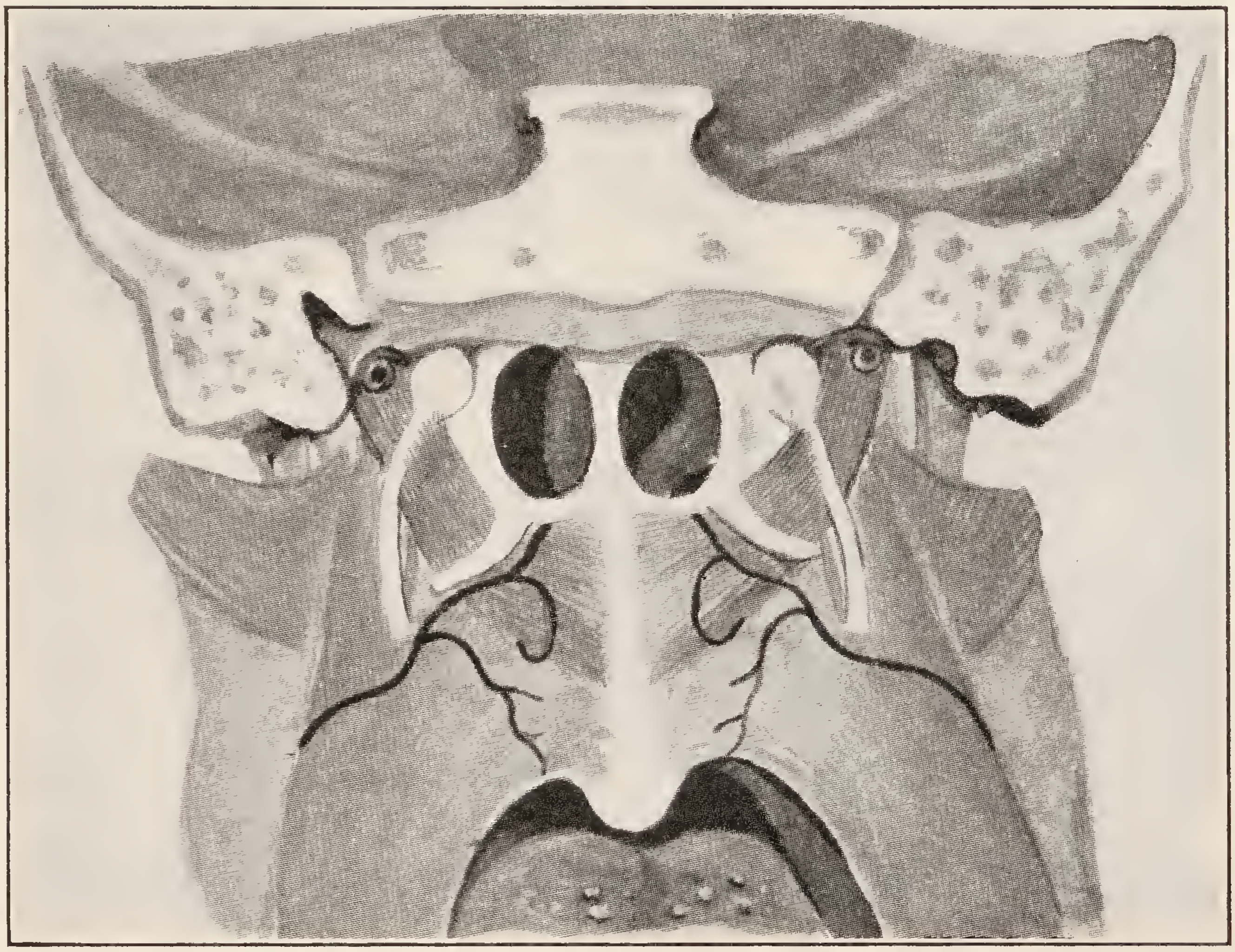


FIG. 575.—Posterior view of palatal muscles together with the ascending palatine artery.

tissue. It is essential, therefore, to utilize all of the tissues available to form a palate of sufficient length to enable the patient to articulate distinctly. Too frequently we find that the distal border of the soft palate does not reach the posterior wall of the pharynx. While the surgeon who makes lateral incisions may close the cleft, he will find the short, thick, scarred palate will not bring to the patient the benefits anticipated. Any operation, therefore, which includes the making of lateral incisions of the soft palate and completely dividing the tensor palati muscle will be followed by defective speech and hearing (Fig. 575). The division of this muscle is *worse than useless. It is unnecessary and positively detrimental to the best interests of the patient.*

9. By reason of the cleft of the soft palate, the muscles do not develop as

perfectly as they would if the tissues were united and brought into normal action. Like other muscles, they need exercise to bring them up to a high state of development.

It should be, therefore, the aim of the surgeon not only to close the cleft of the palate, but to avoid incisions with their resulting cicatrices; to preserve the continuity of the mucous membrane; and to lengthen the palate, if possible, so it will reach the posterior pharyngeal wall. This method of procedure will insure to the patient the best results obtainable. The making

Fig. 576.—Tripartite cleft palate showing both central and right lateral incisor alveoli. Left lateral incisor probably developed in the maxilla. (*Specimen* 206, *Royal College of Surgeons, London.*)

of lateral incisions posterior to the tensor palati muscles has been advocated and practised. These, too, are unnecessary. The only lateral incisions required are those through the membranes covering the hard palate for the purpose of closing holes and in lifting the palato-pharyngeal muscles in the operation of lengthening the palate.

REMOVING SUTURES

Following operations described, *Forms* 1 *to* 6, *inclusive,* or operations on children over six months of age and adults, the lead plates, silver and horsehair sutures should remain in place ten days, when they should be removed. Patients old enough to be controlled will hold the mouth open and assist

the operator in removing the sutures. Patients who resist the operator may, in some cases, require an anesthetic. The oral speculum introduced enables the operator to remove the sutures with little difficulty since it depresses the tongue and gives him a perfect view of the parts. The removal of the lead plates should be very carefully done, as they may drop backward into the pharynx, fall into the trachea or be swallowed. In older patients, with the speculum in position, whether the patient be anesthetized or not, the twist of the wire is seized by delicate forceps, drawn downward a little and, with suitably formed scissors, the anterior wire is cut close to the plate. Then the wire on the opposite side is seized by the forceps, drawn downward, and the posterior wire is cut close to the plate. The plates, remaining still in position, are held by the wires which pass through the tissues. The operator will have an abundance of time to enable him to seize the plate on one side and lift it away, after which he seizes the opposite plate and lifts it away. Prior to adopting this plan of removing the plates, I regarded the taking of them from the mouth as one of the most difficult and hazardous procedures attending the surgical treatment of the soft palate.

In patients under six months, for whom the bones have been placed in contact, the removal of the sutures is accomplished always without an anesthetic and with the greatest ease. They should be permitted to remain for six weeks, as we must regard the treatment, when the bones are moved together, in the same light as we would the treatment of a fracture and allow the bony union to take place before the splints, so to speak, are removed. It is preferable to cut the wires beneath one lead plate, which can be done easily by slightly lifting it. The plate is then removed. No little hooks should be left on the ends of the cut wires, where they were bent. The opposite plate is then seized by hemostatic forceps and lifted away with the wires which extend through the bones to the plate just removed.

LENGTHENING THE PALATE BY UTILIZING THE PALATO-PHARYNGEAL MUSCLES

Following an operation upon the palate, especially one in which lateral incisions have been made, though the palate unites it is sometimes found to have been shortened, and, while improvement in speech is made, the defect is not entirely overcome. To meet the requirements in such a case the palate should be lengthened.

In previous pages I have pointed out that in cleft palate patients the pharyngeal muscles, by reason of the greater activity and use to which they are subjected, become broader and thicker than in a normal palate. They are seen as broad, flattened bands extending from the palate downward and outward to be inserted in the posterior part of the thyroid cartilage (Figs. 578 to 579). By utilizing *two-thirds of each muscle* and adding it to the end of

the palate, we are able to secure as long a palate as we wish (Fig. 580). The distance posteriorly and the difficulty of securing a good view of the muscles of the pharynx make the operation an extremely difficult and tedious one.

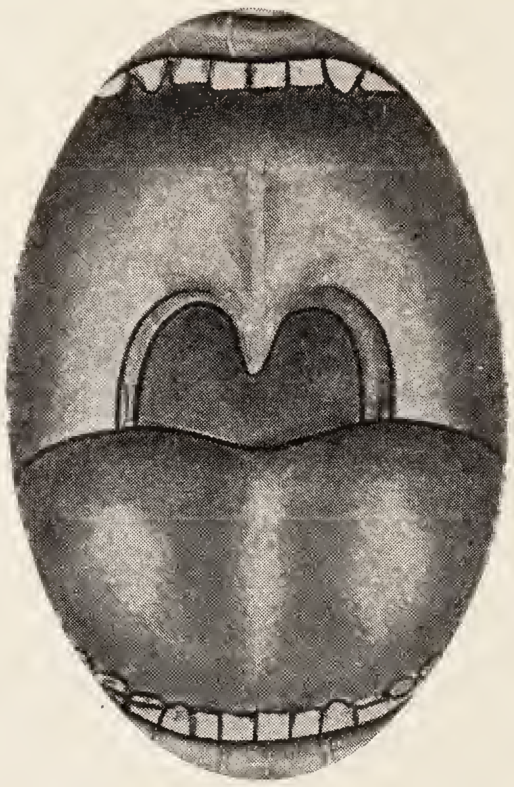


Fig. 577.

Fig. 578.

Fig. 577.—Showing normal palate in complete relaxation. (*Makuen.*)

Fig. 578.—Showing contracted soft palate after operation with a large opening impossible of closure leading from the oral to the nasal cavity. (*Makuen.*)

By utilizing the pharyngeal muscles shown in Fig. 580 the palate can be made as long as desired. (*Brophy.*)

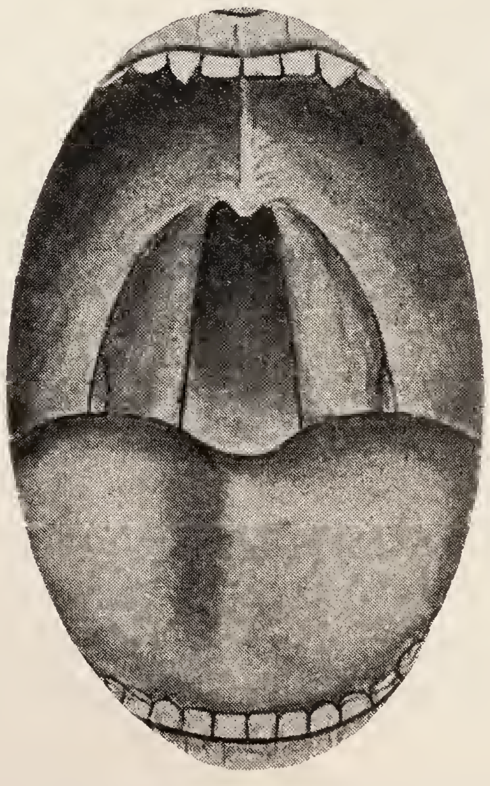


Fig. 579.—Same as Fig. 578 with levator muscles in contraction, the oral cavity entirely cut off from the nasal cavity, and the palato-pharyngei muscles in position to perform their cord stretching function. (*Makuen.*)

The muscle should be picked up and the edges freshened as low down as we desire to make use of it. Having the muscles freshened on each side, we introduce two wire tension sutures (Fig. 581), to which we fix lead plates.

Before placing the lead plates in the mouth in contact with the tissues, we introduce one silk suture through the lower end of the freshened surface of the muscles. The object of using silk in this place is that we need greater strength than horsehair will afford to hold these parts together while placing the other sutures, which should be of horsehair. With the horsehair sutures adjusted, they are held by the use of hemostatic forceps, but not tied until after the plates have been carried into place. The freshened edges of the muscles move into contact easily. After the wires have been twisted upon the plates and the edges approximated, the horsehair sutures are tied. The

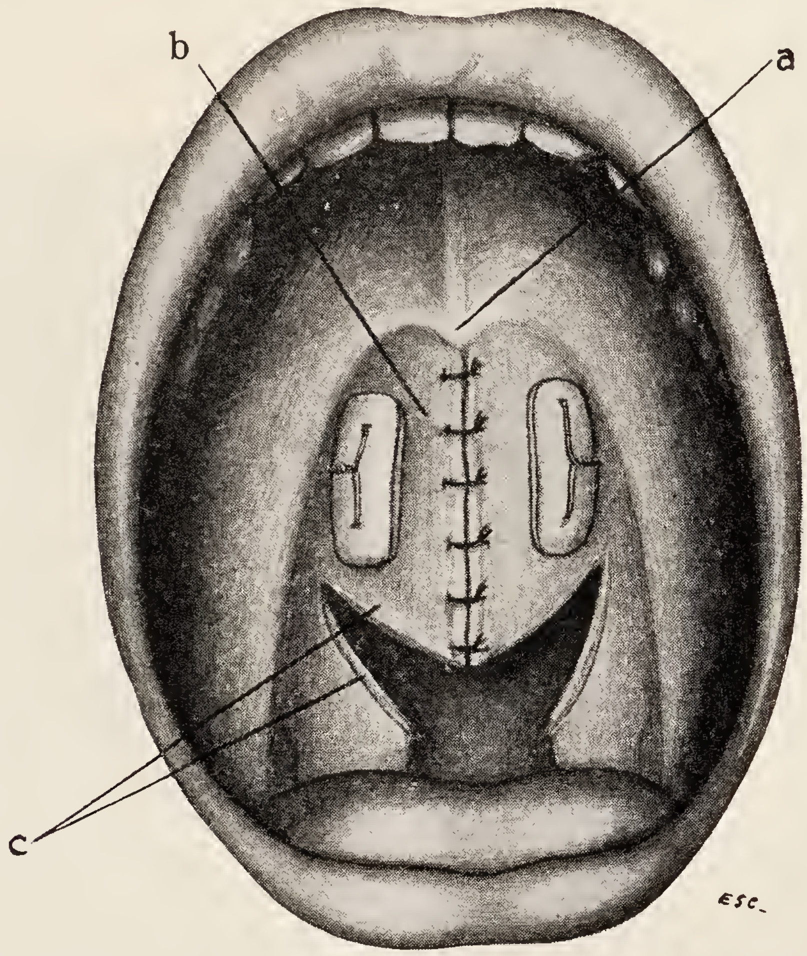


FIG. 580.—This figure illustrates the manner of lengthening the palate by utilizing the palato-pharyngeal muscles. This is after Makuen's Fig. 578. *a*, End of azygos uvula. *b*, Right palato-pharyngeal muscle. *c*, Incision made through two-thirds the width of the muscle. The lead plates are shown with the silver wires twisted so as to approximate the edges of the wound.

plate is then carefully adjusted to the parts. This should be so done that it will exert even pressure upon the soft parts throughout its entire length.

After the wires are twisted on the lead plates, the freshened surfaces approximated and the horsehair sutures tied, the next step is to seize the muscle at the posterior end of the palate and divide it from below upward a little below the plates (Fig. 581). The function of the muscles of the pharynx is not impaired while the palate is lengthened sufficiently to enable it to come in contact with the posterior pharyngeal wall. By the use of the silver tension sutures and lead plates, the parts are held in contact, thus securing a union of the freshened edges. The success attending this operation, not only in securing union of the parts, but in bringing great relief and satisfaction to the patient, has been most gratifying (Figs. 582 and 583).

The palate is made long enough by this operation to close the post-pharyngeal opening. It can be made flexible and resilient by proper massage. This will enable the patient to speak distinctly. The muscles of the pharynx will develop to the desired extent. The power of muscular tissue to develop is well shown in Fig. 357. If half as much effort were bestowed on the exercising of the muscles of the palate after operation as the athlete devotes to the enlargement of the muscles of the arm, most gratifying results would be more often obtained.

MORTALITY OF CLEFT PALATE OPERATIONS

Dr. H. G. Ohls of the Chicago Board of Health gave me the following

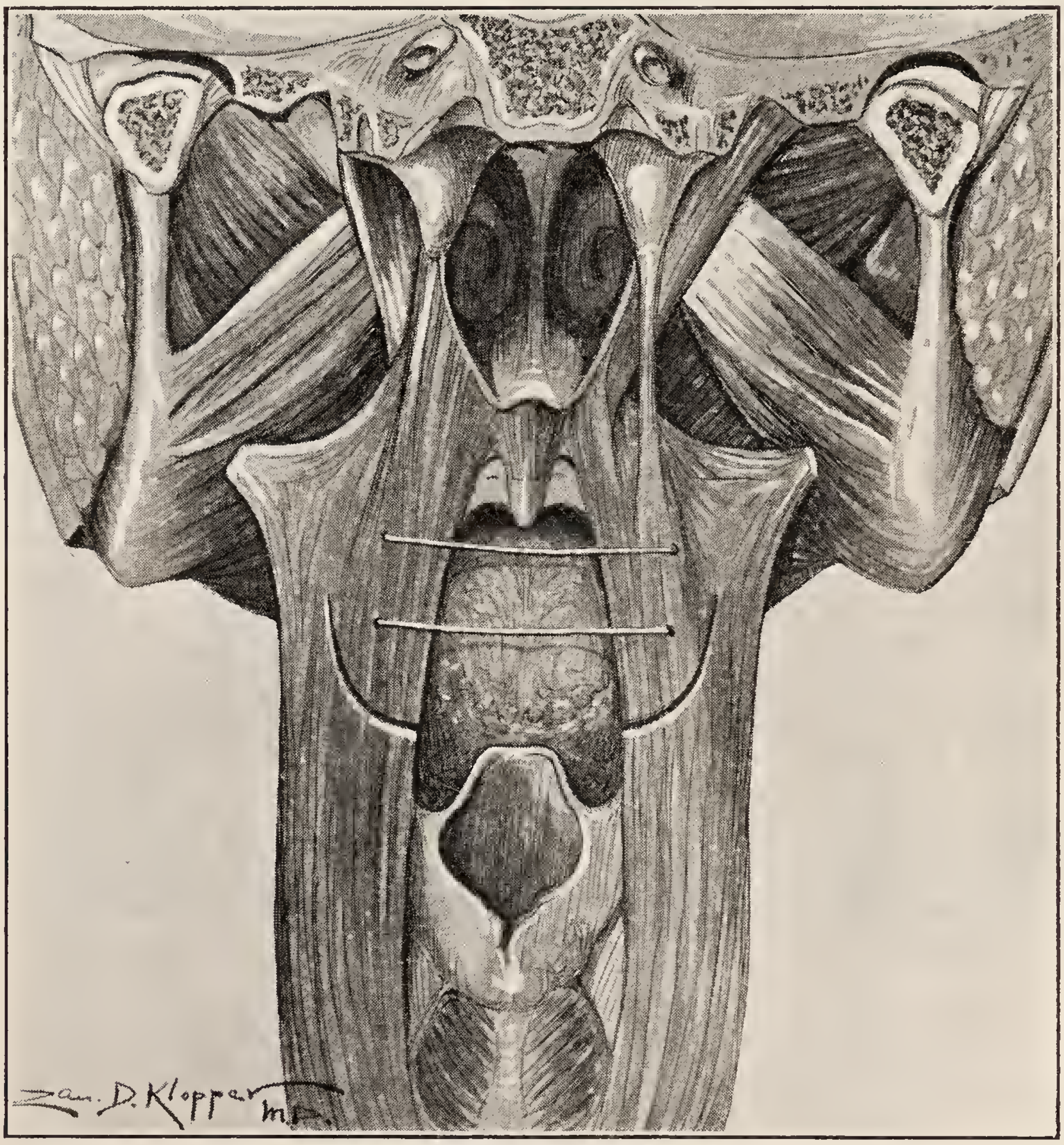


FIG. 581.—Manner of lengthening palate by utilizing portion of pharyngeal muscles. Showing posterior view with wires in place.

figures for this city. He states there were 59,594 births reported. During the year 1914 there were 6880 deaths in children under one year.

Deaths occurring in infants under 1 year..........	6880
Deaths occurring in infants 1 to 2 years...........	1432
Deaths occurring in children 2 to 5 years..........	1343
	9655

It is justifiable to figure the death rate of infants according to the number born. From the above, the death rate in infants from all causes in 1914 is 11.54 per cent. This does not differ materially from the death rate following my cleft palate operations. The results of my last cases show a very marked decrease in the mortality. I believe this is due to more exacting requirements as to the general condition of the infant before operation and to improved technic. By comparison we find Chicago's death rate in infants under one year is more than three times greater than the death rate following my operation in the same year. The mortality rate in New York City and other large cities does not differ materially from the city of Chicago.

FIG. 582.

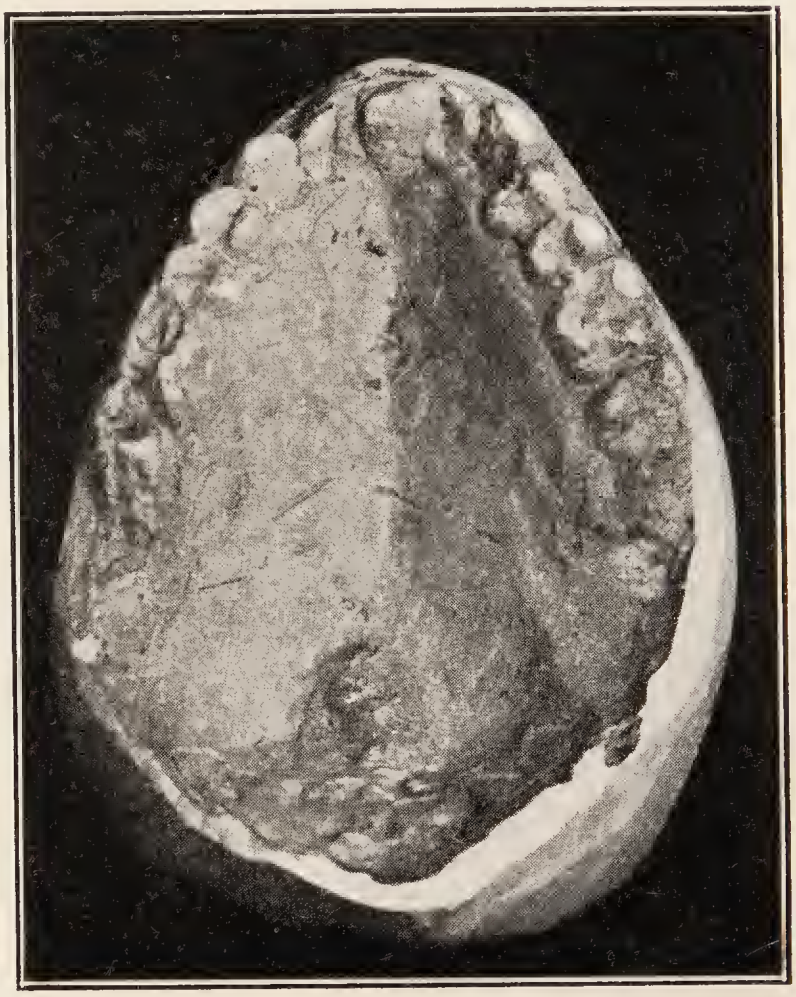


FIG. 583.

FIG. 583.—Plaster cast of short soft palate before (Fig. 582) and after operation. The palate has been lengthened one inch.

In computing the death rate I have not endeavored to separate the patients who died from other causes than the cleft palate operation. I have recorded all who died while under my care. I usually have these patients under observation for at least two months, more often three. Many of them have died when they have been under observation for three months. The greater number have succumbed to gastro-enteritis. The operation has not had anything to do with the death. They undoubtedly would have died whether operated or not. To be fair in the matter, I have included them all.

It would be useless for me to endeavor to compile an array of figures for the reader to consider. The figures are given and anyone interested can compute them any way he sees fit. I do know that the results obtained

have been remarkable. It is a well-known fact that cleft-palate infants after they reach a couple of months of age are usually underfed and a very poor physical risk. The child just born is usually well fed and has not had its digestive organs disturbed. It is, therefore, a better operative risk than the infant who has had the nurse, mother, doctor and the neighbors try the various proprietary preparations on it. Since I have insisted that the infant should be brought into good physical condition and the proper food given, I have had much better results, as will be seen by reference to the table.

AUTHOR'S RESULTS IN CLEFT PALATE OPERATIONS

Age	Operations	Deaths	Last cases[1]	Deaths
1 month	259	48	21	3
2 months	299	51	14	0
3 months	191	10	11	0
4 months	154	10	6	0
5 months	83	18	2	0
6 months	81	6	6	0
7 to 12 months	205	7	25	0
1 year	344	51	22	1
2 years	77	4	18	0
3 years	202	12	3	0
4 years	130	1	4	0
5 years	98	5	0	0
6 years	62	0	4	0
7 years	68	1	0	0
8 years	66	0	0	0
9 years	30	0	1	0
10 years	42	1	0	0
11 to 15 years	240	1	12	0
16 to 20 years	265	0	13	0
21 to 25 years	157	1	9	0
26 to 30 years	162	0	14	0
Over 31 years	57	0	2	0
	3272	227	187	4

PERCENTAGE TABLE

	All cases	Last cases[1]
Percentage of deaths of all ages	6.94	2.14
Percentage of deaths under 1 year	11.78	3.53
Percentage of deaths from 1 to 2 years	14.82	4.54
Percentage of deaths from 2 to 5 years	5.50	0.00
Percentage of deaths from 5 to 10 years	1.85	0.00

[1] These include cases operated during the past year. They have also been figured in the first two columns. No distinction has been made between those cases which died of the first or second operation.

Many authors of eminence, including Lawson Tait, state that the death rate among children with cleft palate who have not been operated upon is from 25 to 50 per cent.

Among the many surgeons who *know my technic* and who have used it successfully for many years, Vilray Papin Blair states: "The immediate mortality of the Brophy operation is very low. We have twice lost three-month children within twelve hours after operation. We have seen a few infants die some weeks or months later after operation; but this has occurred only among cases in which the nutrition of the infant was persistently bad beforehand, and the operation was undertaken in the hope of improving the condition. In these latter cases death could not be attributed directly to the operation, although no doubt it had been a contributing factor. We think it fair to state that we have seen a much larger percentage of deaths among infants that we were trying to get into shape for operation than in the first few post-operative months."[1]

ACQUIRED CLEFT PALATE

Pathological.—Acquired cleft palate may be pathological or traumatic. Syphilis is the most common cause of the pathological form of cleft palate, as it so frequently involves the bones of the nose and hard palate. The soft tissues may also be invaded. The disease manifests itself usually in the nose first, invading the floor of the nares, the membranes being destroyed by a process of ulceration, the bones becoming exposed and, in time, necrotic. The soft parts covering the hard palate ulcerate, the necrotic bone finally exfoliates, leaving a hole, varying in size from a small sinus to an opening as broad as the palate. The management of an abnormality of this character calls for more than surgical interference. The patient should undergo a long course of treatment, the ulcerations should have healed and the tissues be brought back to a condition such as would warrant the surgeon in proceeding with an operation. For medical treatment and care of the patient, see page 60. The methods to be employed in the surgical treatment of the defect do not in any sense differ from those described under the head of secondary operations (Figs. 560 to 571). It is unnecessary to state that an operation attempted for the cure of a defect of the palate from syphilitic ulcers, before the patient has undergone a long and successful course of treatment, would be almost certain to result in the sloughing of the parts, leaving a condition much worse than that which preceded the operation. If, however, the disease has been sufficiently eradicated from the system to allow slight wounds to heal promptly, an operation may be made with reasonable hope of success.

Traumatic.—Traumatic defects of the palate do not occur often in young children, though in my own practice, a child three years of age, in playing with a small china doll, fell upon it, thrusting the doll's arm into her mouth.

[1] Surgery and Diseases of the Mouth and Jaws, page 166.

The palate was perforated, leaving a hole one-fourth of an inch in diameter. When I was called to see it, the hemorrhage was considerable, but this was quickly checked by plugging the cavity and no treatment was required later except to freshen the edges from time to time and, at the end of three weeks, the cavity closed by the formation of granulation tissue. A workman employed in a lumber yard was struck in the mouth by a large hook suspended from a derrick. The hook passed behind the hard palate, was forced upward through it and into the nose, separating the bones and leaving an opening three-fourths of an inch in diameter. The fragments of bone were hanging to the soft parts when the patient came into my hands. All of these were returned to their proper positions, the teeth were ligated together, a few stitches put in the soft parts, and in four weeks the defect of the palate was completely removed.

Gunshot wounds and bayonet thrusts furnish examples of palatal injuries calling for surgical treatment. In such cases, the displaced parts should be readjusted as carefully as possible and suturing done when necessary to hold them in position. As in the treatment of all wounds, the parts should be irrigated and made as clean as possible, prior to the adjustment of the fragments, and antiseptic cleanliness should be faithfully carried out under the care of the operator. Injuries of the palate have occurred during operations upon the throat and tonsils, which call for surgical treatment. Sometimes we have palatal defects as sequelæ of measles, scarlet fever and diphtheria, also from the removal of tumors of the mouth and nose. So far as operative surgery can remove the defects, the technic of the surgical methods previously described will meet the requirements in each case. Should plastic surgery fail to overcome the defect, prosthetic methods may then be employed.

CHAPTER XXIX

THE MECHANICAL TREATMENT OF CONGENITAL CLEFT PALATE

By Calvin S. Case, D.D.S., M.D.

The deformity of congenital cleft palate, as I have endeavored to point out in the consideration of the subject, should be treated surgically in early infancy and the parts united before the child has arrived at the speaking age. It is too apparent to require argument that every defect or deformity, congenital or acquired, should be corrected by surgical methods when possible. In neglected cases, while many of them are amenable to surgical treatment, followed by correct speech, we sometimes find the parts in older patients atrophied. Where there is not sufficient tissue to enable the surgeon to produce good palates, the most modern forms of artificial palates should be constructed to enable patients to overcome defects in articulation.

I have pointed out that an operation, followed by union of the borders of the cleft which has been accomplished by employing lateral incisions, the making of scar tissue and the shortening of the palate, is of little or no value to the patient in assisting him to speak plainly. If the palate cannot be lengthened by utilizing the palato-pharyngeal muscles so as to enable the patient to speak well, an obturator should be used.

The following from the pen of Professor Calvin S. Case, a master in the field of prosthesis, I add to my work on congenital cleft palate:[1]

"Some authors have made quite a distinction between an obturator and a velum so that the profession has come to regard an obturator as any cleft palate instrument which is composed of hard material, gold or vulcanite, and a velum as one composed of flexible rubber after the form of the Kingsley palates. Both are essentially for the correction of speech by restoring a lost or undeveloped portion of the natural palate by artificial means; correctly speaking, therefore, they are both artificial palates.

When Dr. Wm. Suersen proposed the insertion of a cleft palate instrument which could be worn with comfort and, in conjunction with the muscles, enable the patient at will to close the connection between the oral and nasal cavities, he presented a scientific principle that is as true today as then, and one, moreover, that must be successfully attained to be of value to the wearer, whatever the form of the instrument or the method of its construction.

He called the instrument which he devised for this purpose an 'obturator,' because it was intended to close and prevent the passage of air, which is the vehicle of voice, from escaping into the nares.

[1] Dental Cosmos, Vol. XLVII, No. 9.

Later, Dr. Norman W. Kingsley, who will always be regarded as one of the greatest geniuses of his day, realizing the difficulties of constructing and successfully applying the Suersen device, invented a flexible rubber palate (Fig. 999, p. 1072, Am. Sys. Dent.). He named it an artificial velum, because its posterior extension was intended to imitate the action of the natural velum, by bridging the cleft and restoring the palate to the possibilities of a normal organ of speech.

It doubtless has done more than any other device that has ever been invented to relieve the ills of this most unfortunate deformity, principally because it could be inserted and worn with comfort, even though quite imperfect in its adaptability to the parts, and though more or less inadequate in possibilities for the acquirement of perfect enunciation and tone. But Dr. Kingsley and others who adopted this method of practice, I believe, have always been convinced of its inefficiency when considered as a permanent appliance, if for no other reason than the early deterioration of flexible rubber when worn in the mouth, requiring that the palates be renewed about as often as once a year to keep them in the necessary form. This is not difficult for those who construct individual molds for each case, in which the palates can be easily vulcanized and mailed to any part of the country. But in a long experience of its use, I have found that three-fourths of the patients soon tire of this régime, and either discard their palates altogether or get along in some way with what must be very poor apologies.

So that at best the most ardent admirers of the Kingsley velum regard it preliminary to a perfectly constructed obturator in a completed operation.

Dr. R. Ottolengui, in discussing my paper at the National meeting, said: 'The only advantage of a soft velum over an obturator seems to be that it enables a more rapid progress in the acquirement of speech, but later in life, perhaps at the time when the patient needs a new instrument—in any event speech having been perfected—it is usually preferable to make a hard rubber appliance, which will be more permanent and more cleanly than one of soft rubber. Thus the obturator apparently comes into use after the patient has been educated to speak by means of the soft rubber appliance, which should, in every sense of the word, be a velum.'

Though Drs. Kingsley, Ottolengui, myself and others have always advised the changing of vela for metal or hard rubber instruments, the instances are rare when this has been done, principally because it involved another complete operation considerably differing from the first.

In some instances there has been an attempt to change the Kingsley vela for hard rubber obturators made after the very ingenious method and form devised by Dr. Grant Molyneux; but, largely because the shape and conditions were so entirely different, with the consequent irritation to the sensitive tissues, the patients could not be induced to wear them, and insisted upon continuing with the original palates which gave them no discomfort and when new and perfectly fitted enabled them to speak with the most satisfying results.

Then the question arises: If the hard rubber or other so-called obturators are ultimately superior, why not make them in that way at first?

Those who have had considerable experience in the fitting of artificial palates know very well how difficult, and in most instances impossible, it is to make a first palate that does not require considerable change in form before it perfectly subserves the purpose of vocal articulation. Nor can this always be accomplished skillfully until the palate has been worn for some time, and the tissues allowed to become accustomed and adjusted to this foreign body in the mouth and throat.[1]

Through a desire to take advantage of the benefits afforded by a soft rubber appliance on the one hand, and a hard rubber obturator on the other, and at the same time avoid the possibilities of the final inefficiency of the one and the difficulties in construction and adjustment presented by the other, has arisen the present artificial palate, which it is the object of this paper to present.

It essentially consists of a form of palate which can first be made of soft rubber and possess all the advantages of the Kingsley velum, and then when the patient has become accustomed to it in its flexible state, and its present form is assured, by packing the same casts in which the soft rubber palates were vulcanized with another quality of rubber, a hard rubber palate is produced which possesses all the advantages of a perfect obturator.

If made of soft rubber and vulcanized within specially constructed metal molds, as this system demands, the operation is a perfectly painless one, and the first palate can be worn without irritation or special inconvenience; after which, desired changes in its form, that are nearly always required to perfect the palate, can then be easily made by slightly enlarging or contracting the mold.

In my first paper I presented it as composed of soft rubber alone, not having had an opportunity to judge of its merits when made of hard rubber. Dr. Ottolengui, in opening the discussion, said: 'I had always thought until tonight that it would be necessary for those who treat these cases mechanically to decide between a hard rubber obturator and a soft rubber velum, but Dr. Case has brought us a new appliance. He states that it differs essentially from the Kingsley velum, and it certainly does, not only in form but in action and every feature. Of course it is not a hard rubber obturator, but I consider it an obturator rather than a velum.'

Those who are familiar with the Kingsley palates, which I am pleased to say I have used with great satisfaction in my practice for over twenty years, will remember that the veil or posterior portion of the palate is sustained by extending the central thickened portion into it, and from this point it is gradually flattened to a comparatively thin edge, where it is more or less curved in conformity to the pharyngeal wall, against which it is intended to rest during the contraction of the pharyngeal and palatal muscles.

[1] Italics are mine. T. W. B.

In this particular it is quite different in form from the palate I am about to describe, in that with the latter all the central portion of the palate is thin, while the edge of the veil is thick, in the form of a solid roll about one-fifth of an inch in diameter, or preferably triangular, with rounded corners, so that its outer flattened surfaces exactly and firmly fit the pharyngeal walls *when the muscles are in a contracted state.*

Fig. 584 represents the lingual view of the artificial palate in position.

In extensive clefts the borders of the veil extend forward along the lateral walls of the pharynx and posterior nares, and becoming thinner, form the borders of the nasal extensions which rest upon the floor of the nares.

When the cleft does not extend into the hard palate, the veil is shaped in a similar manner, but with the nasal portion abridged to meet the requirements of the case.

When the cleft extends into the hard parts, the body of the palate which covers the borders of the cleft and forms the lateral wings on the roof of the

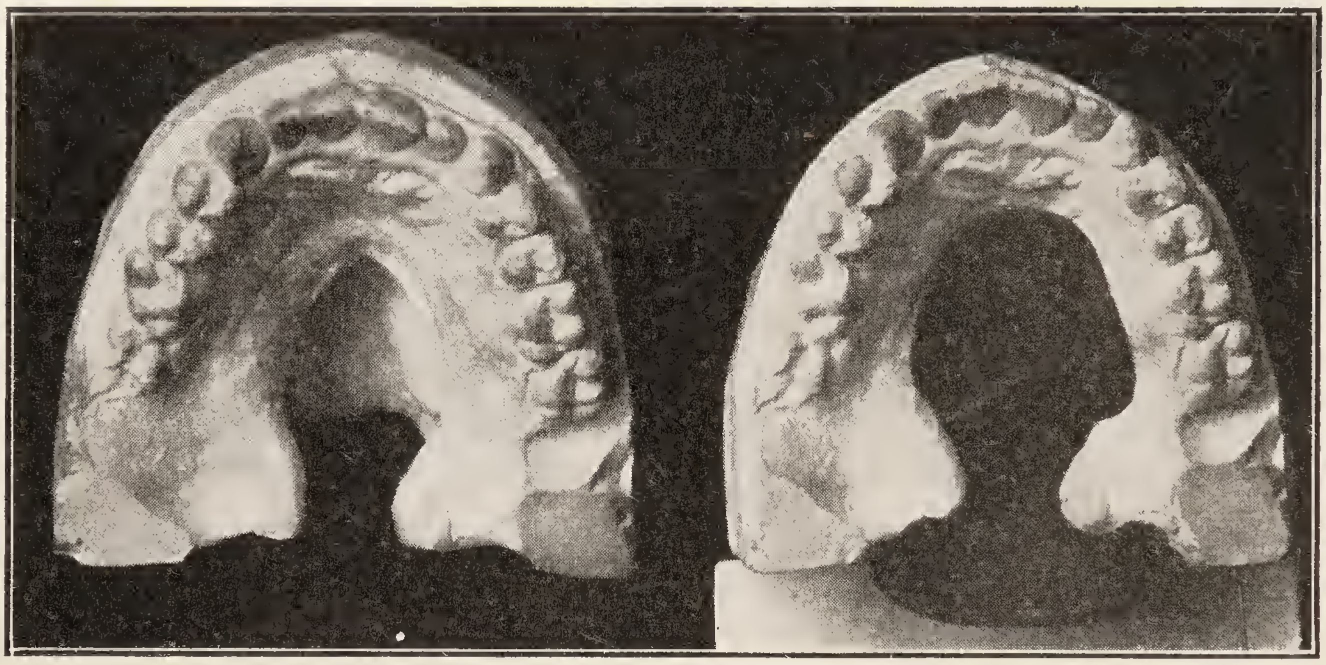


FIG. 584.—A typical congenital cleft and obturator in position.

mouth should not extend back of the attachments of the bifurcates velum palati, nor in any way interfere with the free action of the muscles; neither should it extend upon the roof of the mouth any farther than is necessary to give a firm seating for the palate. This portion should be about as thick as an ordinary rubber plate, being thinned along its oral borders and thickened to form the nasal borders.

There are a number of important advantages in this form of palate, even when made of flexible rubber and used for the purposes of a velum:

First.—The early deterioration of the rubber, causing the curling up of thin edges of the veil, is entirely prevented. When this occurs, as it frequently does with ordinary vela, the vocal usefulness of the palate is impaired—if not destroyed—in proportion as it permits the escape of air at the curled-up portion of the border.

Second.—The heavy border of the veil is sufficiently yielding and flexible

to be worn with comfort if properly fitted, and it also presents sufficient stability and breadth of surface to permit firm contact of the pharyngeal muscles in closing the naso-pharyngeal opening.

Third.—In more or less extensive clefts the thin central portion extending forward into the body of the palate permits a resilient yielding of the lateral portions of the body, which frequently allows one to spring it into place with sufficient grasp of the irregular borders, along which it should accurately fit, to hold it in position without other aid. Whenever this can be accomplished with the soft palate, it will readily be continued when it becomes hard.

In taking an impression for the construction of this palate where the cleft is extensive or even extending somewhat into the hard palate, it is my object to obtain a perfect model of that portion of the roof of the mouth over which I wish the palatal portion of the plate to extend, and along the borders of the cleft forward of the pendent portions of the velum palati, extending somewhat upon the floor of the nares and representing as perfectly as possible the nasal borders of the cleft and lateral surfaces of the posterior nares.

These surfaces, a part of which lie above the pendent and unstable tissues of the velum palati, are frequently susceptible of being perfectly reproduced in the model of a plaster impression. It will usually be found in a typical case that the posterior nasal openings are laterally constricted, from which point the nasal fossæ widen to form the floor of the nares. By obtaining a perfect impression of these somewhat unyielding surfaces, which otherwise, on account of their position, would be very difficult to reproduce, the anterior borders of the artificial veil can be perfectly fitted to them as they merge into the nasal borders of the body.

If a supporting plate seems to be required (which is rare with the most modern form and construction of the velum obturator) it should be no more than a narrow band across the roof of the mouth and clasped to the first molars or second bicuspids. To the upper surface of this, solder a short spur which tips forward, with no more than a clinging hold to prevent the palate from slipping back. The spur should not obstruct or interfere with the up and down movement of the veil, which imitates the natural movements of the velum palati in speaking. This is its one scientific advantage of being worn without a supporting plate.

Preparatory to taking the impression for an artificial palate, I study well the cleft and surrounding tissues to determine the character and extent of the impression. For all clefts that involve the hard palate, an accurate plaster impression of the parts outlined is not more difficult than most impressions for partial dentures.

As a rule, I prefer plaster alone, dividing it as above in sections at the borders of the cleft. Fig. 586 shows different views of an impression of an extensive cleft taken entirely with plaster. The first section is passed freely into the nasal cavity with a spatula, stopping it abruptly at the nearest approaching borders of the cleft. The under surface is then lubricated with

a solution of white vaselin, and the first part of the second section is delicately laid on with the spatula, so as not to lift or dislodge the upper section. The plaster is spread out over the roof of the mouth with a spatula, and when partially hard is strengthened for removal with fresh plaster introduced in a flat impression tray. The impression does not need to extend even to the gingival borders of the teeth.

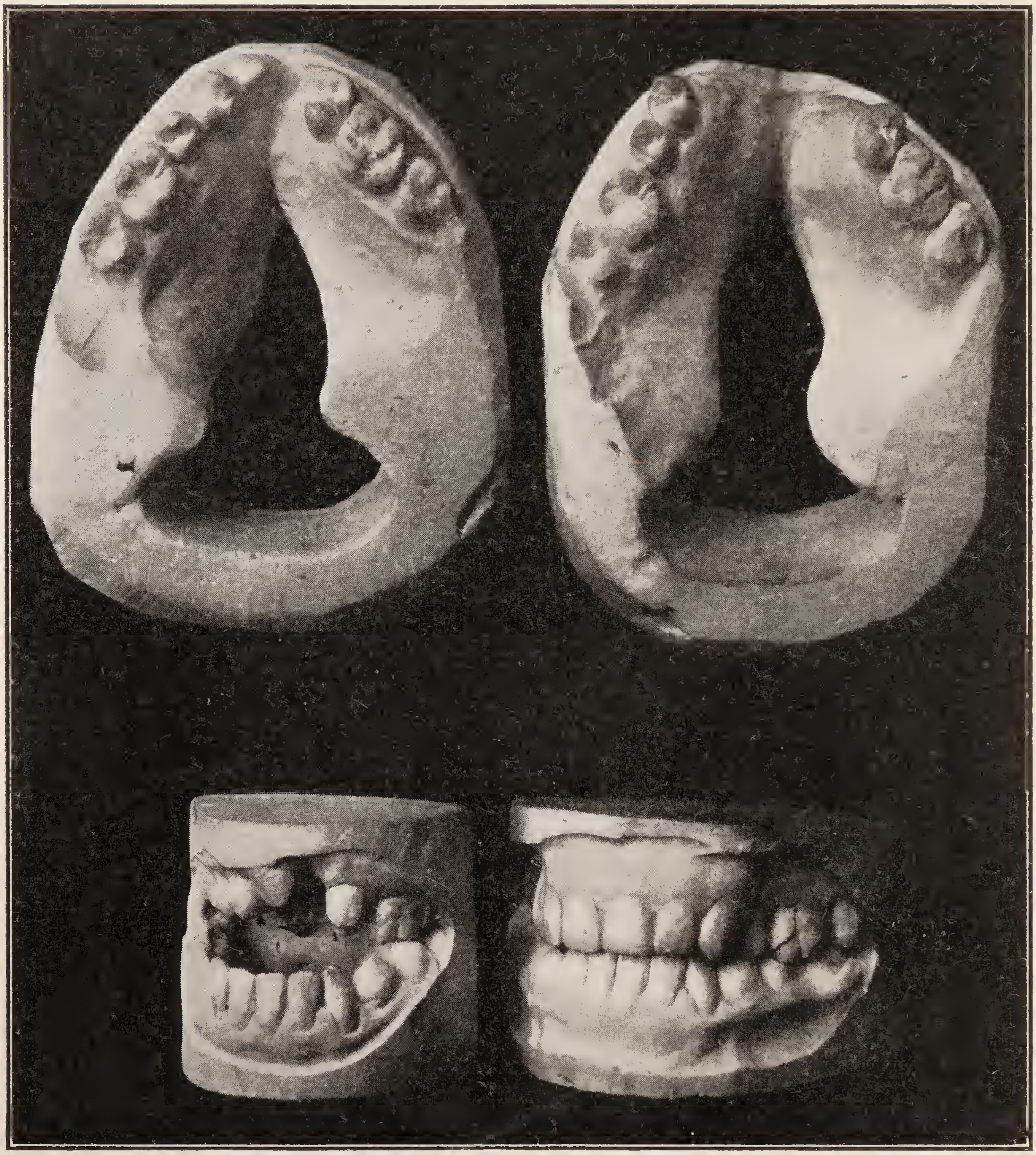


FIG. 585.—Showing expansion of cleft palate arch, alignment of teeth, and restoration denture.

In filling and trimming the models from these impressions, nearly all that portion back of the attachments of the soft palate is cut away, and the nasal portion opened and freely exposed to the extreme nasal borders, produced by the impression.

This is done to facilitate shaping the trial model of the palate, and its

ready removal and replacing during the process of repeated trials in the mouth.

The trial model of the body of the palate is formed first and then inserted in the mouth for trial, etc. At this time the lateral nasal extensions should be abridged to facilitate introduction. They can be added at the time of investment, and, if desired, still further extended by scraping the metal casts.

The position for the border surface of the veil is determined with a loop of small soft copper wire, No. 20, the ends of which pass into thin tubes about half an inch long, imbedded in the upper surface of the trial model.

The loop is drawn out to about the proper size and shape, and the trial model inserted into the mouth for correction, etc., until the wire is seen to rest along a zone of the pharyngeal walls that is best adapted to unite in their muscular action with the artificial veil for the ultimate closure of the naso-pharyngeal opening.

The path of this pharyngeal zone, which practically should extend from the lateral extension of the nasal borders on each side back to a line immediately in front of or slightly above the greatest contracted extension of the superior pharyngeal muscle, is carefully chosen to avoid impinging upon the Eustachian opening, and to obtain the most active possibilities of the muscles. The surrounding muscles can be made to contract by a slight titillation of the surface, and, what is of the greatest advantage, the pharyngeal walls above and below the wire can be readily seen through the open loop, and the action of the muscles studied.

As the loop turns forward to pass beneath the Eustachian opening, the pharyngeal surfaces will often be found corrugated and thrown into irregular folds, so that in finding the smoother path across these ridges, to prevent the escape of air at the border of the veil through these sulci, it may be found desirable to raise or lower the wire upon one side more than the other. Forward of this it soon comes in contact with the upper surfaces of the palatal muscles.

After fitting the wire to mark the desired outlines of the veil, the roll of compound which is to form the model of the border may be attached to the loop, following the outlines of its peripheral surface.

When this is introduced and the muscles caused to contract, its position and requirements can be readily seen. By repeated trials, its required form and relations are produced. The line of the peripheral surface of the border of the veil in the trial model, should follow the lines of the muscles along its zone *at the moment of their greatest contraction, and should never be allowed to more than barely touch and yet close every irregularity of their contour.* Later (after the first palate is vulcanized and worn a few days) if it is found needful to extend the border at any place to aid the patient in completely closing the palato-pharyngeal passage, it can be easily accomplished by scraping the metal cast. This should be done cautiously because the subsequent

functional efforts of the muscles to completely close an almost closed opening will cause them to develop surprisingly. This is due to the efforts in uttering all the consonants except m, n and ng. *To leave the largest possible opening at the borders of the veil, when the muscles are relaxed,* is of the greatest importance to speech and healthful breathing. If these rules are followed with a proper choice of the palato-pharyngeal zone, together with a perfect and sufficiently extensive fitting upon the nasal floor, the Velum Obturator will be worn with perfect comfort, safety and unconsciousness of its presence,

Fig. 586.—A typical two section impression.

from the very start and without a supporting plate in most instances. Furthermore, patients under twenty soon learn to speak with such perfect articulation and tone that a stranger would not suspect their deformity.

I can see no reason, furthermore, why the pharyngeal contact surface of the palate should be any wider than necessary to enable stability of muscular contact, as seems to be presented by the Molyneux pattern, nor do I see that the central portion of the palate needs to be thicker than is sufficient to stop the air, which is the vehicle of voice.

If the diaphragm be a thin plate of rubber or gold, valuable resonating and nasal breathing space will not be obstructed.

I at first named this palate the 'velum obturator,' because it stands for both, but as Dr. Ottolengui has said, it is more of an obturator than a velum, and yet it is one which, if made of soft rubber vulcanized within metal molds and properly constructed according to the method and principles I have outlined, presents to the patient and the operator all the advantages of a soft rubber velum.

The principal advantage in this system of preceding the operation with a soft palate is not that it can be worn with greater comfort from the start, nor that it enables the patient to more readily acquire perfect speech—though these are important—but that it admits of more readily determining the slight variations in its form that may be necessary and possible to alter by changing the molds in which it is vulcanized, until you have reached a form that is exactly suited to the demands of the surrounding tissues for the acquirement of perfect enunciation, resonance and tone. When this has been accomplished, the palate is easily changed from a soft to a hard rubber obturator by simply packing the same molds with hard vulcanite instead of soft.

In the first change to hard rubber, I usually leave the nasal portion and veil soft, and the part over the roof of the mouth hard. In the next change only the veil is soft. All of these changes may usually be completed inside of a few weeks. In fact, if I find the first soft palate is to my liking, subsequent ones are made all hard. They are far more cleanly, are worn with fully as much comfort and I think with greater security; besides, what is of far more advantage, they produce a clearer, more perfect tone and resonance of speech."

CHAPTER XXX

THE TRAINING OF SPEECH AFTER CLEFT PALATE OPERATIONS

By G. Hudson-Makuen

Importance of Palate.—There is a popular notion that the tongue is the chief organ of speech and that the sense of taste is located in the palate. When a person is talkative, he is said to have a "long tongue"; when he is caustic in his remarks, a "sharp tongue"; and the Biblical reference to the "unruly member" is well understood. Moreover, it is not an uncommon thing to hear it said that certain articles of food and drink "tickle the palate." Physiologically it would be more accurate to refer to the palate as being the "unruly member" and to regard the tongue as the organ in which is located the sense of taste.

Both the palate and the tongue are important organs of speech, but the former is the more so, for not only is it essential in the enunciation of nearly all the elements of speech, but, owing to its direct attachment to the larynx, it is also an important factor in the production of voice. The vowel sounds may be articulated when the palate is defective, but their resonance is so much impaired that they are scarcely recognizable and their pitch cannot be changed with any degree of accuracy. It is in the articulation of consonant sounds, however, that the palate is especially essential.

The Consonants.—Of the twenty-three consonant sounds, only two, the "m" and the "n" can be given intelligibly when the palate is not intact, and even in these the resonanace is somewhat impaired. All those consonant sounds in the enunciation of which the tongue is a conspicuous factor, the th, hard and soft, s, z, sh, zh, t, d, n, l, r, k, g, ng, h, y, as well as those in which the lips and teeth are used, the p, b, m, wh, w, f and v, are impossible to a person with a defective palate. This is true because, in the enunciation of these sounds, the palate is necessary to confine the breath to the oral channel and to prevent it from passing up through the nasal chambers.

How Made.—It will be borne in mind that the consonant sounds are made by impeding the moving column of breath at certain points above the larynx. The points at which the impediment takes place have been called the stop positions. These have been divided into the anterior, the middle and the posterior stop positions. The anterior one is formed by the lips (in the articulation of the so-called labial sounds, p, b, m, wh, w), by the lower lip and the teeth (in the articulation of the labio-dentals, f,

v), and by the tip of the tongue and the teeth (in the articulation of the linguo-dentals, th′, th″); the middle one by the tongue and the hard palate (in the articulation of the anterior linguo-palatals, s, z, sh, zh, t, d, n, l, r); and the posterior one by the dorsum of the tongue and the soft palate (in the articulation of the posterior linguo-palatals, k, g, ng, h, y). For all these sounds requiring an impediment in the outgoing column of breath, whichever stop position may be used, it is necessary to have a freely movable and normal palate.

PHYSIOLOGICAL TABLE OF SOUNDS

Vowel Sounds

E.	A.	Ah.	Aw.	O.	OO.

Consonant Sounds

	Voiceless oral.	Voiced Oral.	Voiced Nasal.
Labials	P.	B.	M.
	Wh.	W.	
Labiodentals	F.	V.	
Linguodentals	Th′	Th″	
Anterior Linguopalatals	S.	Z.	
	Sh.	Zh.	
	T.	D.	N.
		L.	
		R.	
Posterior Linguopalatals	K.	G.	Ng.
	H.	Y.	

Function of the Palate.—The function of the palate in the articulation of consonant sounds, therefore, is two-fold. In all those sounds in which it does not assist in the formation of the stop position, it serves as an obturator between the nose and the pharynx, completing the partition between these two cavities and compelling the outgoing breath to pass through the particular stop position required for the sound. For instance, in the articulation of labials, labio-dentals and linguo-dentals, the sounding breath must pass through the anterior stop position, and the palate serves to diverge it in this direction and to prevent it from passing through the nostrils. In a similar manner, when the hard palate is intact and the middle stop position is used, as in the articulation of the linguo-palatals, the sounding breath must pass through this constricted aperature, and the function of the palate is to prevent it from passing upward through the nostrils. In the use of the posterior stop position, which is formed by the junction of the velum palati and the dorsum of the tongue, the soft palate serves a double purpose. Its free border rises against the posterior pharyngeal wall, closing the avenue to the nostrils, and its anterior surface, acting in conjunction with the tongue, forms the stop position for the sound. In the enunciation of these posterior linguo-palatal sounds, a perforation of the hard palate would have little

if any, effect upon the articulation, but it would somewhat modify the vocal resonance.

Interference of Speech Due to Palate.—It will be observed that the tongue and the palate act together in the processes of articulation and that the palate also serves to prevent the sounding breath from passing through the nostrils and to focus it upon the particular stop position that is being used. The various defects of the palate that interfere with speech are:

1st. Paralysis of the muscles.

2nd. Perforations.

3rd. A lack of union between the lateral halves, commonly known as a "cleft palate."

The paralysis of the muscles of the palate may follow diphtheria or some other infectious disease, or it may be the result of external violence and, inasmuch as it interferes with the valvular action of the palate and allows the breath to pass up through the nose, its effect upon speech is somewhat similar to that of a cleft palate.

A perforation of the palate affects speech more or less, according to its size and location. If it is in the hard palate, anterior to the stop position which is being used, its effect may be scarcely noticeable, but if it be posterior to the stop position, whether in the hard or the soft palate, its effect is very marked, and if the perforation is a large one, its effect is similar to a cleft in the palate or a paralysis of the levator palati muscles.

Characteristic Speech of Cleft Palate.—The characteristic speech of one having a cleft palate is familiar to all, but its physiology may not be so well understood. The impaired resonance of the voice, caused by a cleft in the palate, is more marked than we should expect, and it illustrates how important is every part of these mechanisms to the normal voice. In addition to this impaired resonance, the cleft palate interferes with the inflections of the voice and thus destroys its natural melody. Moreover, the mechanism or physiology of speech is entirely changed. The formation and practical use of the three stop positions above mentioned are impossible in cases in which the palate is cleft. The anterior and middle stop positions may be formed by means of the lips, the teeth, the tongue and the hard palate (unless this be cleft throughout its entire length), but they never are formed because it is impossible for the patient to focus the vocalized breath at these points when there is a free channel for it to pass up through the cleft and out through the nostrils. The posterior stop position cannot be formed because, as I have explained above, its formation depends upon a freely movable and normal palate.

The purely vocal sounds, therefore, are the only ones that can be even approximated when the palate is cleft and they, as I have shown, are defective in respect to resonance and melody. The consonant sounds are generally almost entirely unintelligible and they are made with a totally different mechanism. For the three normal stop positions, the patient en-

deavors to substitute others further back in the pharynx. For some sounds the base of the tongue and the posterior wall of the pharynx approximate to form the stop position, and for others the lips of the larynx formed by the arytenoid cartilages, the arytenoid and the aryepiglottic folds are used. With such substitutes for the normal stop positions, situated as they are far back in the throat, it is not surprising that the articulation and phonation should be so defective and indistinct.

Explanation of Defective Speech.—It will be observed that the three defects of the palate, which I have mentioned, have a similar effect upon the character of speech. There is this difference, however. Paralysis of the muscles of the palate and perforations are usually acquired defects and generally appear after the development of the faculty of speech, while the cleft palate is congenital and comes before the development of the faculty of speech. In the former two conditions, normal speech has merely been interrupted, while in the case of a neglected cleft palate, no normal speech has been developed. This explains in part why the speech of a person with a cleft palate is more defective and less intelligible than the speech of those having paralysis of the muscles or perforations. The indications for treatment in the latter two conditions are, in the one, to restore the normal action of the muscles involved, and in the other, to close the perforation either by means of natural tissue or some mechanical appliance. When this is accomplished, the speech generally approximates the normal condition or that condition which obtained before the defect appeared.

Speech Habits.—In the case of the cleft palate, however, where only abnormal speech preceded the defect, we have a very different condition of affairs. It will be remembered that the acquirement of speech habits begins early in the second year and continues during the period of childhood. It is during this time that Nature provides for the normal development of speech. Children appear to inherit a tendency toward speech development and cases have been reported in which whole sentences have been uttered spontaneously without any preliminary practice. The more serious forms of defects of speech are those that are acquired during this formative period. It is then that faulty impressions of the elements of speech are stored in the auditory centers of the brain and faulty habits formed in the use of the various mechanisms of speech.

When to Correct Defects.—Other things being equal, therefore, all anatomical or structural irregularities having a tendency to impede the normal development of speech during this period should have our most careful attention, and *measures for the correction of these conditions should be adopted as early as possible, before the cerebral impressions and peripheral habits are established.* Inasmuch as surgical measures for the closure of the cleft palate are undertaken largely for the purpose of improving speech, *they should be employed as early as possible before the formative speech period.* Surgical measures, as a rule, however, give the patient only a little better

chance for the development of good speech. Even if we were able to furnish the patient with a perfectly normal palate, it is a well-known fact that the character of the speech would remain almost unchanged, because, as I have explained above, the patient has never learned to use the natural mechanisms of speech, but he has been forced to substitute mechanisms that are inadequate to the requirements.

No habits are more difficult to change than habits of speech. The fact is they cannot be changed without special aid and instruction. This is true, mainly, because the ear of the speaker, having grown accustomed to faulty articulation, does not discriminate between it and the normal articulation and considerable practice is required to train the ear to make this discrimination and appreciate good speech while the organs are being trained to produce it.

To make a normal palate take the place of a cleft palate, the soft parts should be so manipulated as to avoid the formation of scar tissue. If this is done, a palate soft and flexible may be produced. If incisions are made through the soft parts and measures omitted to lengthen the palate, masses of cicatricial tissue will form with contractions.

The two reasons for attempting to close a cleft palate are, first, to improve the physical condition of the patient by giving to him a more nearly normal respiratory tract, and, second, in older patients, to improve both his physical and mental condition by giving to him an approximately normal means for communication with his fellows through the channels of oral expression. The second reason for the operation is even more important than the first because the patient's curious and faulty speech affects him both mentally and physically.

Inadequacy of Merely Closing Cleft.—As I have said, the mere closure of a cleft palate in an adolescent or adult person, does not, as a rule, improve the speech to any appreciable extent. I am aware that there are those who hold an opposite opinion, but in the cases that have been improved, I think some outside assistance has always been rendered. Even the little help that may be given by an intelligent parent is fraught with good results in many instances, but the degree of success that may be obtained is generally proportionate to the skill of the teacher and the ability of the patient for persistent and concentrated effort. It has been said that a faulty habit of speech must be supplanted by a correct one, but it is more than a habit. It is a deeply rooted neuromuscular disturbance or perversion that has arisen from an effort on the part of Nature to accommodate itself to developmental structural irregularities in certain important parts of these mechanisms. It is somewhat analogous to the effort on the part of the neuromuscular mechanisms of the heart to accommodate themselves to a faulty valve, but it is far more complicated because of the volitional and other physical faculties employed in the development of speech.

Movements of the Soft Palate.—As I have shown, the palate is one of the most important organs of voice and speech. Its integrity is essential to the tones of the voice as well as to the moulding of voice into speech by the processes of so-called articulation. The soft palate has a wide range of movement. Its function in vocalization is to assist in controlling the

FIG. 587.—The shaded portions representing the points of contact of the tongue during the emission of the sounds indicated by the accompanying letters. (*N. Y. Med. Jour., July* 27, 1907.)

action of the vocal cords and regulating the size and shape of certain important resonance chambers, and its function in articulation is to shut off the nasal from the oral cavity during the emission of the explosive and fricative sounds, and to form contacts with the tongue in the formation of the so-called posterior linguo-palatal sounds. This will be better understood if we glance for a moment at the accompanying charts.

The table (page 727) contains the physiological alphabet of vowel and consonant sounds. It will be observed that the consonants are arranged in

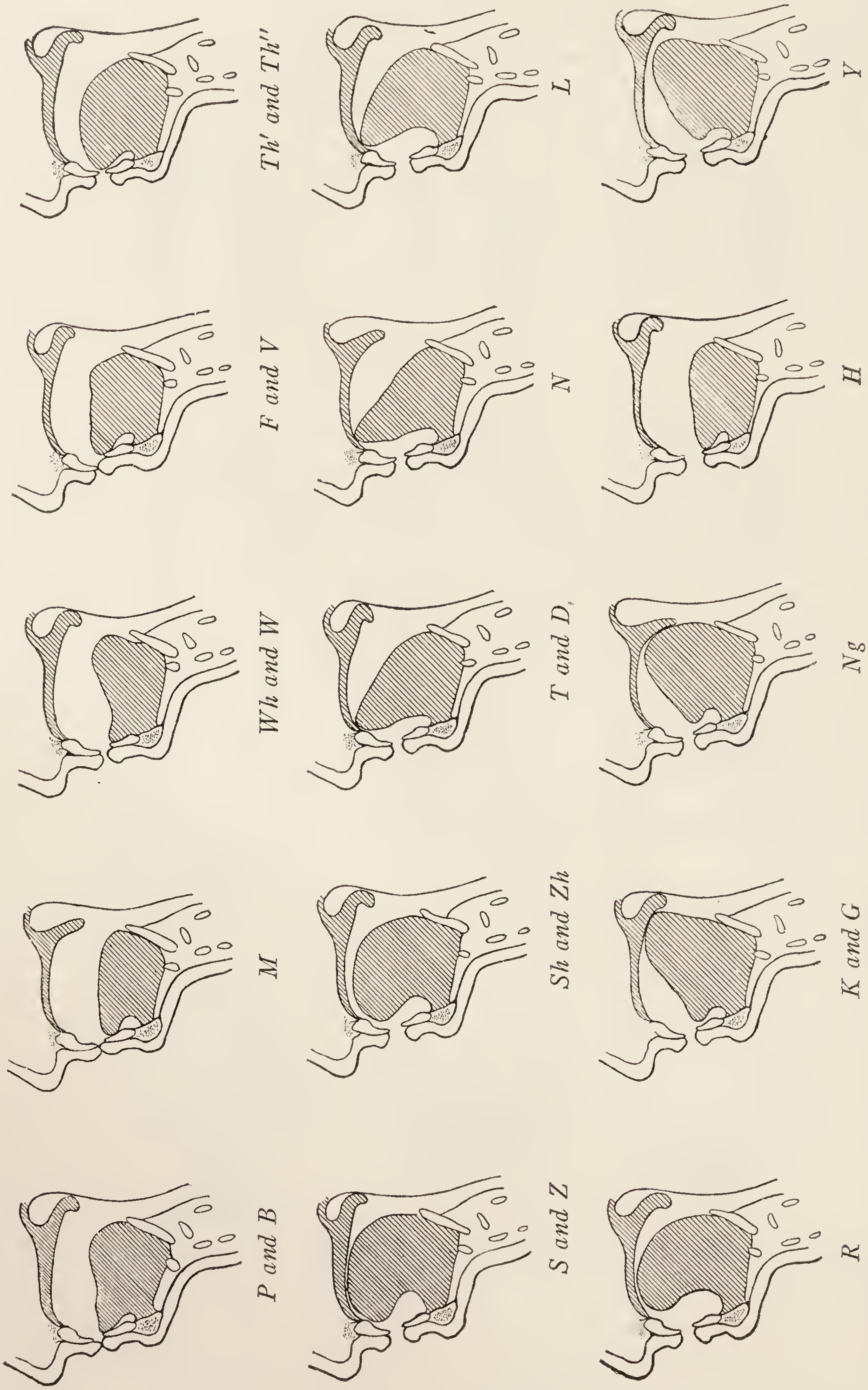


FIG. 588.—Physiological alphabet. Showing the positions of the soft palate and tongue in the articulation of the sounds indicated by the accompanying letters. (*N. Y. Med. Jour.*)

groups and named according to the particular organs of articulation employed in their formation.

In Fig. 587 we have a series of drawings of the palate, alveolar arch and teeth, and the shaded portions represent the points of contact of the

tongue during the emission of the sounds represented by the letters or symbols accompanying them. I may say that these drawings, taken in part from Kingsley's palatograms, are fairly accurate and the last one is a diagrammatic picture of a complete cleft of the palate.

If we compare the normal palate with the cleft palate and glance at the points of tongue contacts in the drawings, we shall readily see exactly what consonant sounds must be faulty when the palate is cleft and these, of course, are the sounds which we hope to improve by our operation. In addition to these, however, there are other sounds that are defective when the palate is cleft, and they are the explosives and fricatives, which require a complete shutting off of the nasal from the oral cavity. This is well shown by the drawings of some vertical sections of the organs of articulation in Fig. 588 which drawings, of course, are merely diagrammatic. I would call attention especially to the position of the soft palate shutting off the nasopharynx during the emission of the explosives and fricatives. By a comparison of the physiological alphabet with these drawings, it will be seen that when the palate is cleft, all the consonant sounds, with two exceptions, will be defective necessarily and, when the cleft extends through the alveolar arch and lip, all will be defective with no exception whatever.

Organ Perversions.—In the absence of the normal palate after the first year, therefore, the patient tries to substitute, for purposes of speech, certain other organs lower down in the throat, such as the epiglottis, the aryepiglottic folds and the ventricular bands, and in this process of substitution, faulty musculatures are developed, including a faulty development of the nerve centers supplying them. This gives rise to the neuromuscular perversion to which reference has been made and which, as I have said, is really more than a habit.

It must be remembered that we are dealing here with a psychical as well as a physical perversion with a faulty development of the central as well as the peripheral mechanisms of speech, including the receptive, the executive and even the intellectual centers.

The correction of these conditions is by no means a simple procedure. The patient himself cannot accomplish it, because his central mechanisms are involved, and he cannot diagnosticate his own case. So accustomed has he grown to his speech that his ear has come to approve it and he cannot discriminate between his faulty forms of speech and the correct ones. He has no ear for correct speech, just as some people have no ear for musical tones and have to learn them by a long and plodding process. Moreover, every day of faulty speech tends to increase these unfortunate psychophysical conditions and to lead the patient farther and farther away from normal speech. The fewer the days of faulty speech, therefore, the better it is for the patient, and hence the importance of doing the operation, if possible, even before the developmental speech period, or within the first year.

Training Needed.—In the adolescent or adult cleft palate patient, training will do more for the improvement of speech than will the operation. In other words, a patient who can have the advantage of but one of the two procedures can probably be given better speech by training alone than by an operation alone. The reason for this is apparent when we consider the limitations of the operation. In the first place, the speech, as I have shown, is defective in three important particulars, namely, in resonance, in melody and in articulation. The extent to which we can improve the resonance and melody of the voice by the mere closure of the cleft is very slight because, however well the operation may be done, the patient will have but limited control of a more or less tense velum and he will be unable, therefore, to regulate the size of the opening between the oropharynx and the naso-pharynx. It is upon the regulation of the size of this opening, which is constantly changing during speech production, that normal resonance largely depends. When the opening is large, as in the cleft palate case, the nasal resonance predominates, and when it is small, the nasal resonance is diminished. Moreover, the rapid changes in pitch, which result in the so-called melody of the voice, cannot be made with any degree of accuracy, because the function of the palatopharyngeal muscles, which have their lower attachments in the superior cornua of the thyroid cartilage of the larynx, is, at least, partially destroyed by the cicatricial contractions[1] which follow the operation and by the atrophy which has taken place from the disuse of these muscles before the operation was performed.

Tongue Contacts.—As to the other particular in which the speech of the cleft palate case is defective, namely, the so-called articulation, our operation is of greater service because, as we have seen, the hard palate and velum are both essential to the normal tongue contacts of certain of the consonant sounds and if the cleft extends through the alveolar arch and lip, nearly all the tongue contacts in the articulation of consonants will be faulty. Not only are the tongue contacts important, but in the production of many of the consonants there is a damming up, so to speak, of the breath in the mouth and a slight explosive effort as the sound is emitted. When this takes place in the normal mouth, the velum rises and shuts off completely the oral from the nasal cavities, and this is one of the things which the velum of a cleft palate cannot do and which it must be made to do before we can get the best results from the standpoint of speech. The velum of the cleft palate, therefore, should be united in such a manner that it will be as large and as loose as possible with its muscles in their normal positions and relations, and then the patient should be given such exercises as will have a tendency to develop in these muscles their normal physiological functions.

[1] Dr. Makuen's opinions are based, no doubt, upon the observations of palates which have been operated on by making lateral incisions through the muscles. As previously stated, these lateral incisions are wholly unnecessary. T. W. B.

Much depends, therefore, upon the way in which the operation is done, but when the muscles of an adolescent or adult patient with a cleft palate have been united in their normal positions and relations, our work has only begun, because these muscles have become atrophied from disuse; they have no so-called tonus and scarcely any power. In other words, they have lost their normal function and, if left to themselves, they would never regain it, and it is this masterful inactivity of the palatal muscles after the operation, that gives to the speech of the cleft palate case its characteristic quality, and it is the restoration of the function of these muscles, more than anything else, which removes this disagreeable quality.

Kind of Training Needed.—From what I have said, we must conclude that the training of the speech, after a cleft palate operation, is an exceedingly important feature of the treatment, and that this training consists in an effort, not only to establish functional activity in important muscles of phonation and articulation but also, to do this under somewhat unfavorable conditions. Fortunately, it is not absolutely essential, in the majority of cases, that the peripheral organs of speech be made structurally perfect in order to enable the patient to acquire fairly satisfactory speech. In other words, the integrity of the peripheral organs of speech is only a factor and, indeed, a comparatively slight factor, in the process of speech development, the chief thing being the integrity of the central mechanisms of speech, upon which is based what has been called the speech instinct. A child with the speech instinct and with a full development of the cerebral mechanisms of speech will be able to overcome many structural imperfections of the peripheral organs, but a gross defect of these peripheral organs, such as a cleft palate, when it exists for a considerable length of time, interferes with the normal development of the cerebral mechanisms and thus destroys, to some extent, the ability of the patient to overcome peripheral imperfections without some special assistance. Our training, therefore, must be such as to affect central as well as peripheral conditions, and it differs not at all in principle from the training that is required for other forms of defective speech. The purpose of the training is to correct faulty actions of certain muscles and to develop normal action in certain other unused muscles.

Exercises.—A good, all-around exercise for the development of the palatal and pharyngeal muscles is a systematic and vigorous gargling three or four times a day with a warm, sterile solution. Another excellent exercise is to have the patient acquire by practice a voluntary control over the muscles of the palate and pharynx. This is done by an effort to elevate and depress the palate at will, under direct vision in a good light and with a mirror. The exercises should be practised regularly and for a long time under the direction of a teacher. Much may be accomplished also by the mechanical stretching of the palate, and for this purpose a sterile finger or some special instrument may be used by the physician. In addition to these general

measures for the development of the mechanisms of speech, a thorough course of training is indicated in both phonation and articulation. Correct breathing is of great importance in this work and exercises should be given to improve the voice, which is especially defective in rhythm and melody.

The training in articulation should be such as to meet the requirements of each individual case. Generally speaking, however, the patient should be taught all the sounds of the Physiological Alphabet and he should be taught to give them as nearly accurately as possible. His ear must be trained to recognize the correct sounds of speech and to distinguish between them and the faulty sounds. All this requires close attention on the part of the patient and long-continued practice under the direction of a skilled teacher. The teacher, to be successful in this work, must understand not only the anatomy and physiology of the organs of speech, but also the effect upon these organs of scientific training.

As early as 1887 Dr. G. V. Black stated: "There is a peculiar fact in connection with the phenomena of cleft palate. We may cut away the lips, the teeth and the tongue and the patient may talk plainly after all, but if we cut away the soft palate, it seems to be utterly impossible for the patient to speak perfectly. Rigid training is the most important element in the remedy of these cases, and we may educate the patient to speak quite distinctly, but, as I have said, the speech will not be perfect; there will be a nasal twang. The muscles that close the nostrils may be brought into use by training. The azygos uvula has the power of projection, and in its efforts to close the cleft, the margins of the muscle will even overlap each other sometimes.

"**Reasons for Failure in Palato-plasty.**—These muscles ordinarily are not used in cleft palate and, if left until adult life, there is atrophy of the muscles owing to lack of use. Now, in order to bring them back into position to close the cleft in the atrophied condition, it requires quite a pull, especially in the anterior half of the cleft. The strong tension under which the muscles are placed militates against the success of the operation. For this reason, operation should be performed in infancy before atrophy of the muscles has occurred. Another very strong reason why the patient should be operated on early in life is to gain an apposition of the parts before any association of speech is formed in the brain. As soon as the child is old enough, it will endeavor to speak whether the cleft is present or not, and if the association of speech has not been properly formed, it is very difficult to rectify it in adult life.

"In operating on these cases, it is always best to avoid severing the muscles. The usefulness of the muscles should not be impaired."—T. W. B.

CHAPTER XXXI

PLASTIC SURGERY

Plastic surgery includes the "repair of loss of tissue or the correction of deformities by incisions and bringing of tissue from the same or another person to fill the gap." The remarkable advance in surgical practice during the past quarter century has made it possible for the surgeon to perform operations, with almost uniform success, which were, prior to that period, regarded as impossible. Surgery of the internal organs, of the cranial, thoracic and abdominal cavities has made phenomenal progress. To the students and practitioners of operative surgery is due the credit for bestowing incalculable benefits upon suffering humanity. In their devotion to improving the methods and technic of the surgery of the internal organs, comparatively little attention has been paid to the æsthetic side of plastic surgery.

Recently John B. Roberts[1] entered very exhaustively into the discussion of the development of plastic surgery, the principles underlying it and the technic employed in all of the operations of the face.

It is not within the scope of this work to enter into the history of plastic surgery from the remotest period to the present time. It is sufficient for our purpose to lay down the principles underlying its practice and to deal with it so far as it relates to the mouth and the parts immediately associated therewith. In the chapter on Harelip (page 512), the surgical methods necessary to secure good results have been described fully. In this chapter we will present the most approved surgical procedure in plastic operations for the removal of deformities of the mouth and parts in close proximity therewith and the restoration of lost parts.

Indications.—The conditions which call for plastic surgery of the mouth and parts associated therewith are: loss of tissue of the soft parts from gunshot wounds or other injuries, loss of tissue in the removal of tumors, destruction of tissue as the result of infection and ulceration, depressions resulting from adhesions following operation, gangrene, burns, mineral poisoning or congenital defects.

Preparation of Patient.—It is essential, before doing a plastic operation, to take into consideration the general condition of the patient. To operate with a view to repairing an injury of a lip resulting from a syphilitic ulcer, without first treating the patient, getting the disease under control and healing the ulcer, would be a most unwise procedure. The various diseases

[1] "Surgery of Deformities of the Face, including Cleft Palate," March, 1912.

which manifest themselves in and about the mouth should be well understood and the parts put in healthy condition before steps are taken in plastic surgery. Those having been afflicted with specific diseases are not favorable subjects for plastics until after they have passed through a thorough course of treatment. Even then the tissues may not behave well after they have been satisfactorily approximated. The surgeon should, prior to doing any plastic work about the face, inform the patient and family that an element of uncertainty always exists and the result may not be all that is hoped for.

There is no operation requiring greater care in preparing the patient than one for plastic surgery. The usual preparation—abstaining from food, catharsis, and colonic flushing—must be supplemented by extreme care in preparing the field of the operation. The skin must be scrubbed with great care; the surface must be as nearly aseptic as possible and, preferably, painted with tincture of iodin.

Principles Underlying.—The underlying principles of the transfer of tissue, as hitherto set forth, must be kept in mind constantly. In all operations for the correction of deformities, the removal of redundant tissue and the filling of deficiencies, certain rules must be observed rigidly. In transferring flaps for covering areas lost by destruction of the skin, the parts must be measured with a view to determining exactly how much tissue should be transferred to cover the defect. A rule to observe is to make the flap one-sixth larger than the space to be covered. Undue stretching of the skin, to make it cover a defective place, should not be resorted to as stretching may arrest the blood supply, in which event gangrene will follow. Too much care cannot be taken in observing this precaution.

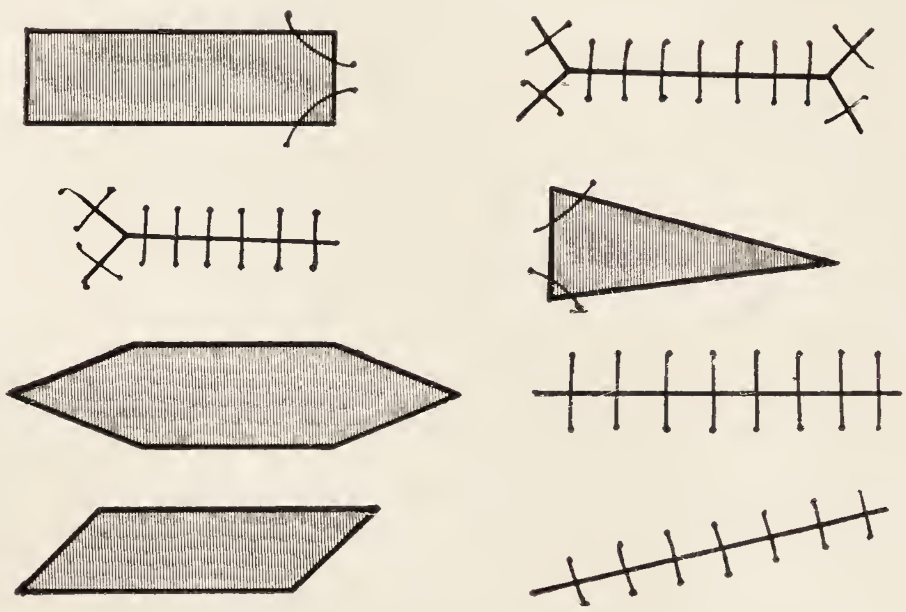


Fig. 589.—Plastic operations. Covering defects by stretching the margins of skin. (*Esmarch and Kowalzig.*)

Certain rules have been laid down by Esmarch and Kowalzig, with diagrams which convey clearly to the mind the technic of the procedure:

1st—By stretching

2nd—By sliding

3rd—Transplantation of flaps
4th—Relaxation incisions
5th—Skin grafting

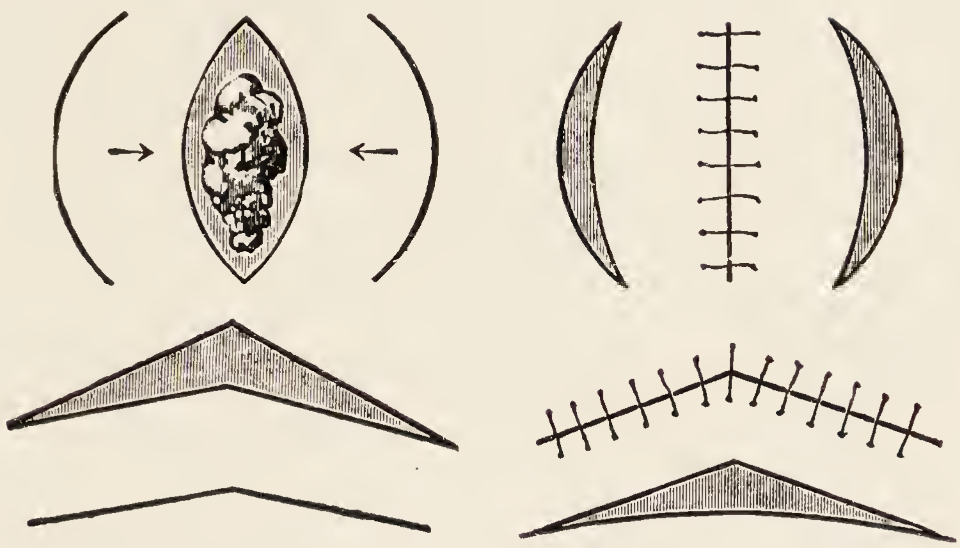


FIG. 590.—Plastic operations. Incisions to relieve tension. (*Esmarch and Kowalzig.*)

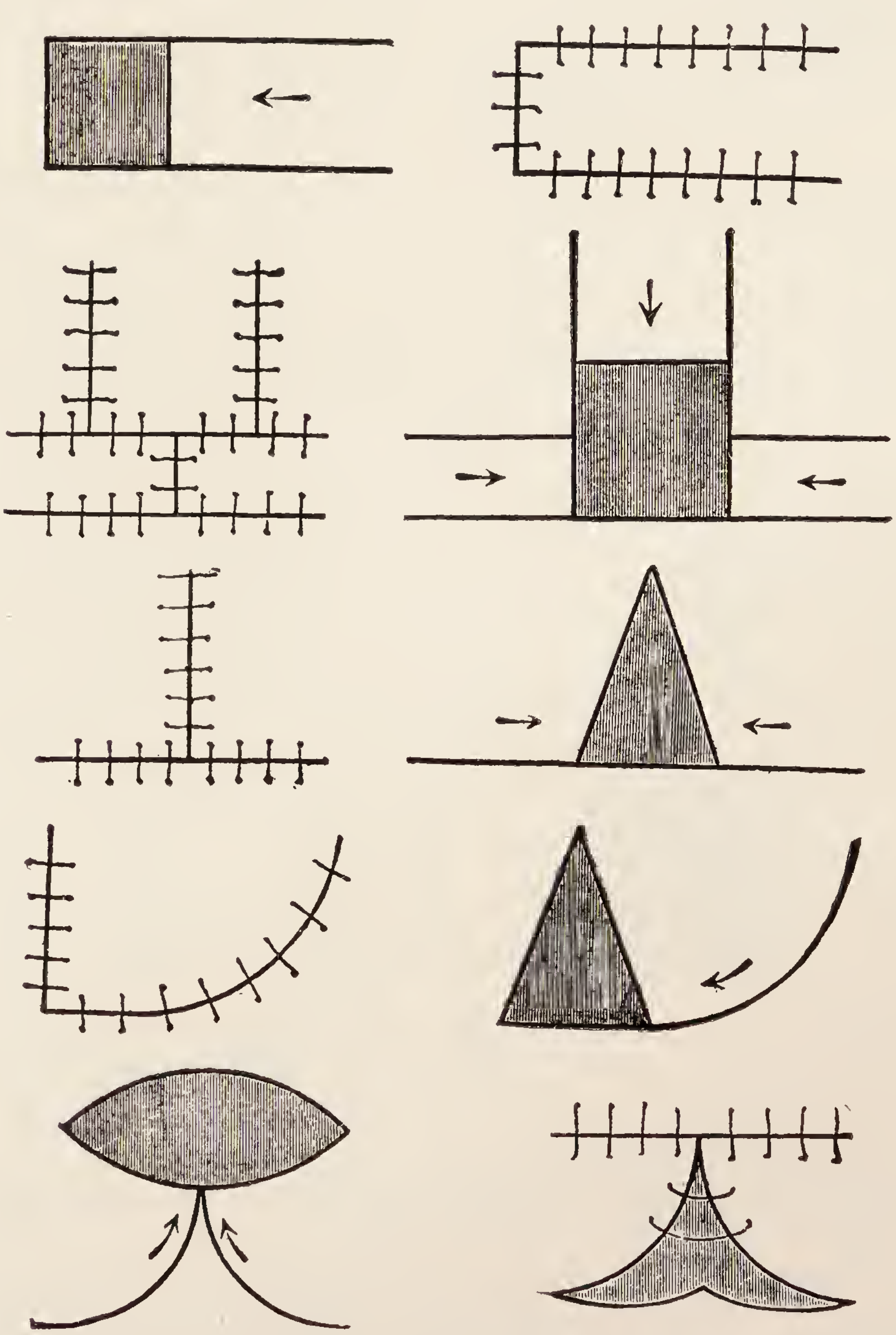


FIG. 591.—Plastic operations by sliding and stretching of flaps. (*Esmarch and Kowalzig.*)

Stretching.—The stretching of the skin must be done with extreme care. The skin should be dissected back for a considerable distance from

the area to be covered and the angle so shaped that the edges may be approximated without leaving redundant folds of skin. After the edges of the skin are accurately approximated, they should be fixed by the use of horsehair sutures. Adhesive plaster may be applied, if necessary to as-

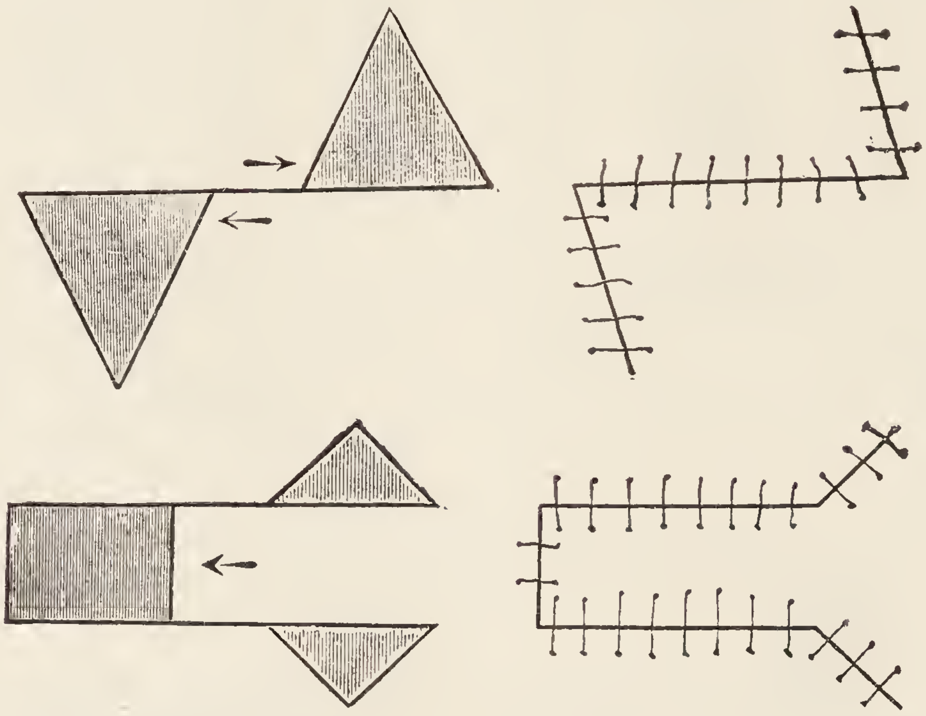


FIG. 592.—Plastic operations with pedunculated flaps. (*Esmarch and Kowalzig.*)

sist in holding the edges of the wound in place (Fig. 279). In this way the open space is reduced to a single straight line. The corners of triangular and square defects are first sutured, the long sides finally being brought

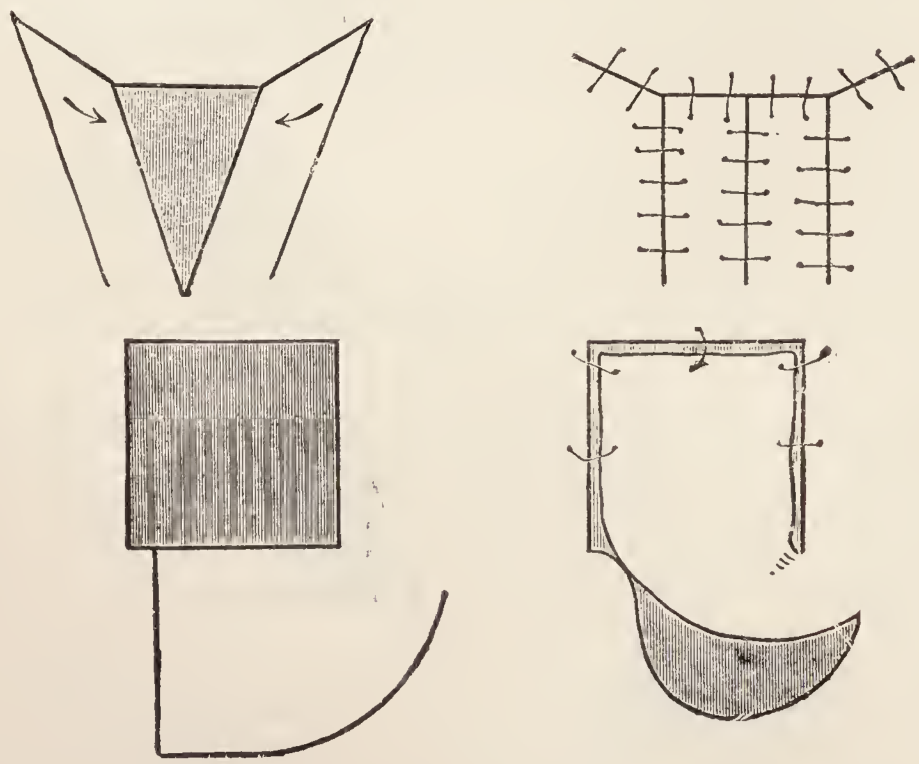


FIG. 593.—Transplanting flaps in plastic operations. (*Esmarch and Kowalzig.*)

into contact. A square defect may be changed into a lancet-shaped one by excision of the two triangles made on its short sides (Fig. 589).

Another course to pursue is demonstrated in Fig. 590. In this it is necessary to make incisions rather deep in the tissue to relieve tension, after which all of the surfaces may be approximated and the wound closed.

Sliding.—The technic of Selsus consists in making straight or curved incisions. One or more flaps are moved over the defect and sutured (Fig. 591).

The method of Burroughs, of excising triangles of the skin corresponding to the defect, is illustrated in Fig. 592.

Transplantation of Flaps.—The third method is by transplantation of flaps, one end of which remains in connection with the vascular supply while the flap itself is carried over the wound and there sutured, according to Fig. 593.

Skin Grafting.—in 1871 an incalculable advance in plastic surgery was made by Réverdin, who successfully employed skin grafting, covering surfaces which were denuded of skin by ulceration and also covering granulating wounds. Without a knowledge of Réverdin's achievement, Hanff discovered that small particles of skin would unite to granulating surfaces and become centers of cicatrization. Ulcerated surfaces, therefore, or surfaces without skin, which were previously considered incurable, were healed quite promptly. The value of skin-grafting, aside from the cosmetic effect, is to prevent extensive contraction and to hasten the healing of skin-denuded surfaces.

To Thiersch, who, in 1886, demonstrated the application of thin shavings of the epidermis, we are indebted for marked improvements in skin grafting. The large shaving of upper layers of the skin, which Dr. Thiersch employed, was not only a valuable innovation in the treatment of wounds on ulcerated surfaces, burns, etc., but it was the beginning of a substantial improvement in this department of plastic surgery. Wolf of Glasgow, previous to the announcement of Thiersch, demonstrated that pieces of skin of moderate size could be transplanted with success. Hairy flaps of skin were used by Huten, following Wolf's method, for the repair of eye-brows. Transplantation of bone, muscle, cartilage and other tissue from one subject to another has, at the present time, become a feature in surgical procedure.

Dr. Alexis Carrel, at a meeting of the American Medical Association, announced that he would send to any member of the Surgical Section for transplantation tissue which had long been preserved at the Rockefeller Institute in New York; that they might plant them with assurance of success, and declared that organs live after removal. Substitutes for the cornea of the eye, diseased parts of the various bones of the body, cartilages which had given out and needed repair could be had from this laboratory, and he freely declared that it had become possible to make these parts live after they had been removed from the body. The value of skin grafting in the preservation of life appeals to us most deeply.

Preparation.—There is no step in surgical procedure requiring more care to establish and maintain asepsis than in skin grafting. A freshened surface, which is not surgically clean, is an unfavorable field for this

operation; in fact, failure to thoroughly clean such surfaces will lead to unsuccessful results. The surface to be covered and the surrounding parts should be thoroughly cleaned antiseptically by the usual washing of the skin followed by normal salt solution. Any cicatricial tissue or semi-organized membrane should be removed. The area, from which the graft is taken, should be cleansed thoroughly and every care taken to prevent infection. If exuberant granulations are present, they should be curetted and the hemorrhage arrested by the use of hot sponges. Disinfectants having escharotic properties should not be employed as they retard, to some extent, the formation of granulations and thus become obstacles to the union of the graft to the freshened surface.

Wolf transplanted areas of skin, from which all fat was removed, one-sixth larger in size than the surface to be covered. This graft was placed in contact with the freshened surface, over which dressings were placed in such a way as to make gentle pressure. After these grafts are made, they

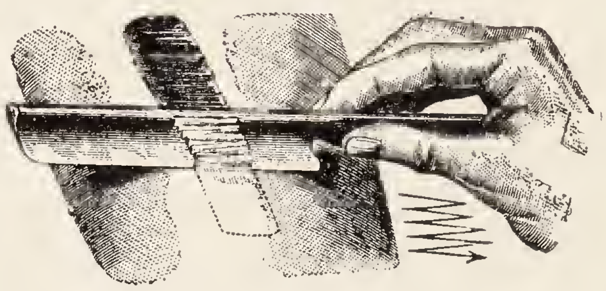


Fig. 594.

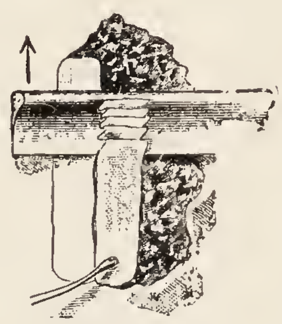


Fig. 595.

Fig. 594 and 595.—Skin grafting according to Thiersch. (*Esmarch and Kowalzig.*)

should not be disturbed for several days, not even to expose them for inspection.

Thiersch's method is most generally used in the treatment of raw surfaces. The surface from which the graft is to be removed, having been thoroughly sterilized by washing with normal salt solution, may be stretched and a thin strip of epidermis removed with a sharp razor (Fig. 594). The graft may then be carried on the blade of the razor to the fresh surface (Fig. 595). The grafts are laid on in strips and this process continued until the exposed surface is covered. Care must be taken that air bubbles are not permitted to remain beneath the graft. Dry sterile gauze, as a dressing, is then employed, held in place by adhesive straps. It is well to allow the dressings to remain in place for a week. Should infection occur, however, the parts should be thoroughly cleansed with normal salt solution, with a view to preserving at least a certain amount of the graft.

Réverdin's method calls for the use of curved scissors. The skin is lifted with a needle and cut away in small pieces. These are placed upon the fresh surface and held downward by the use of antiseptic dressings. These little sections of skin at first seem to melt and disappear, but later the epithelial growth is seen spreading out in all directions and if the grafts

take in close proximity, the intervening space will be closed by the development of new skin.

Margoldt's method is as follows: "Scraping the sterilized skin with a razor down to the papillary layer, and spreading the mixture of epithelial cells and blood thus obtained upon a clean, bloodless, non-granulated wound."

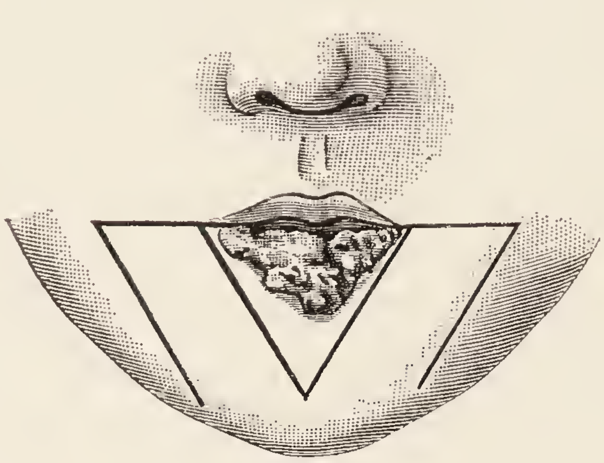
Mucous membrane and skin from animals have been transplanted and skin has been substituted for mucous membrane. In the transplantation of skin to take the place of mucous membrane, it is essential that the skin should be selected from a part of the body which has no hair follicles.

The work of Guthrie, Morestin, Lexer, Hoepfner, Payr, Goreé and Carrel has contributed largely to the advancement of plastic operations and has made them practical. The transplantation of bone as a substitute for a part that has been lost and the introduction of foreign substances into the tissue to remain and overcome defects, the use of paraffin, celluloid and metal parts have been found successful and no inconvenience suffered after years of wear.

Lip and Cheek Defects.—In the chapter on the treatment of Harelip, the technic and surgical procedure have been considered fully and measures outlined for the successful treatment of that congenital defect. It is, therefore, unnecessary to add anything to this phase of plastic surgery except to refer to it now and then in connection with other operations about the mouth. Nor will I concern myself with rhinoplasty, except so far as it has to do with surgery of the mouth. The loss of tissue involving the lips and cheeks from trauma or disease calls for the most exacting technic in plastic surgery. To move tissue from one location to another and thus overcome a great deformity is to render to a patient a most valuable service. Errors in diagnosis of morbid conditions have led to disastrous results. To mistake a specific lesion for carcinoma and remove it by surgical procedure would be a serious error. Such operations, however, are on record. The history of each patient should be studied carefully and the general conditions understood. If he has suffered from specific disease, an operation should not be undertaken until the patient has passed through a course of treatment.

The removal of malignant tumors, masses of cicatricial tissue resulting from burns, or ulcerations from any cause, and restoring the parts by making flaps and moving them into position to take the place of the missing parts has long been practised with beneficial results. The redundancy of the tissue of the lips very often enables the surgeon to remove carcinomatous growths, approximate the edges and restore and preserve a very satisfactory condition of the lip without moving flaps from adjacent parts. Methods of procedure for the restoration of the lips and defects of the cheeks call for the same care in diagnosis as would be employed before performing any other surgical operation.

Epithelioma of Lower Lip.—The development of epithelioma of the lower lip usually appears as a small ulcer upon the surface of the mucous membrane, about which the tissues are indurated (see page 1060) and from which the surface cells multiply until a pronounced growth is formed. If it fails to heal upon the application of the usual surface protecting remedies and if operated upon early, as these growths always should be, it may be removed and the edges approximated without marked deformity. If a large portion



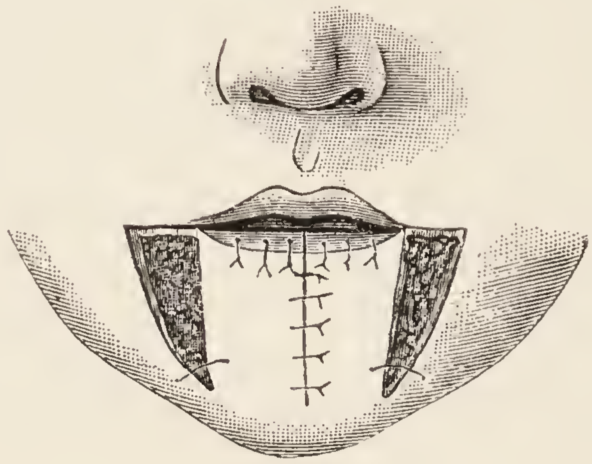
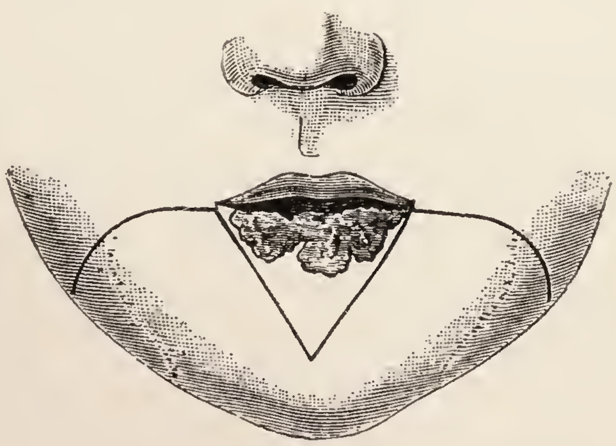


Fig. 596. Fig. 597.
Dieffenbach's cheiloplasty. (*Esmarch and Kowalzig.*)

of the lip becomes involved in the growth, as one-half or two-thirds, after the removal of the growth a flap may be produced and the form of the lip thus restored (see page 544). In the development of carcinoma of the lower lip in patients whose lips are thick and heavy, provided the growth does not involve the integument, but appears only upon the surface of the mucosa, an elliptical-shaped incision may be made through the mucous membrane, the growth removed and the membranes approximated. As



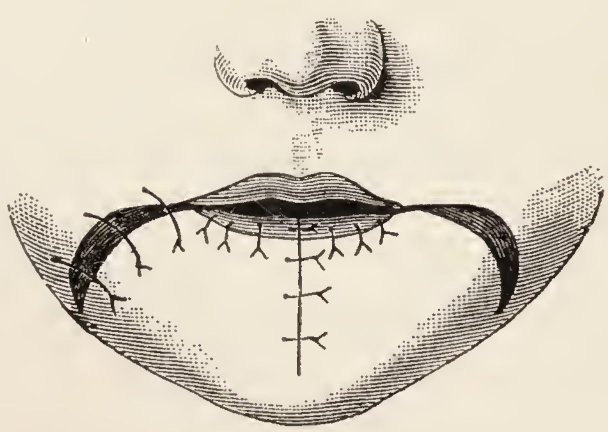
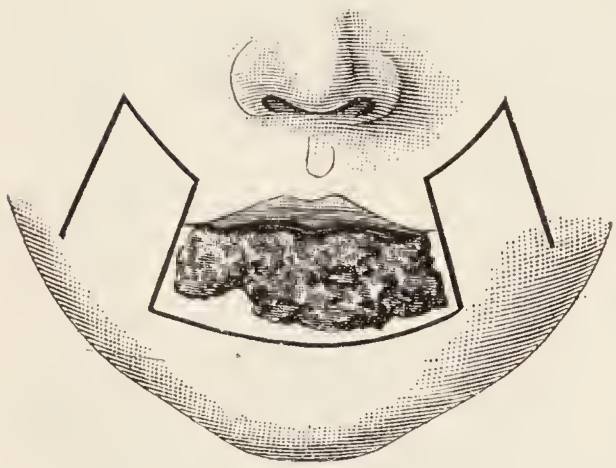


Fig. 598. Fig. 599.
Jasche's cheiloplasty. (*Esmarch and Kowalzig.*)

stated, if the lip is unusually thick, this operation may be made without deformity. On the other hand, if the growth extends deep into the lip, involving the skin as it blends with the mucous membrane, a section of the skin must necessarily be removed.

In case the entire lower lip is involved by a malignant growth, it is plainly the surgeon's duty to extirpate the tissues involved, removing healthy tissue at least two centimeters beyond the limits of the tumor. In mak-

FIG. 600. FIG. 601.
Trendelenburg's cheiloplasty. (*Esmarch and Kowalzig.*)



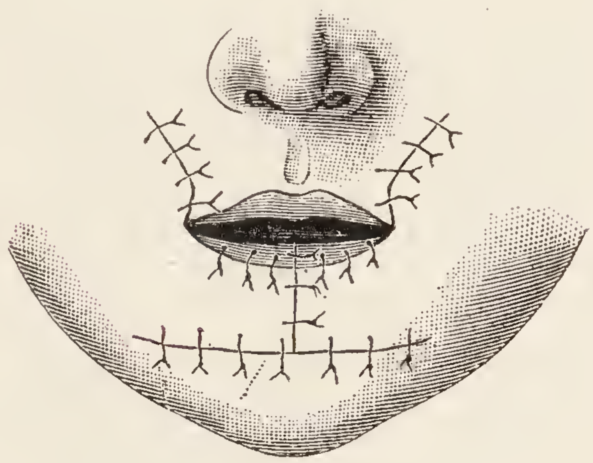
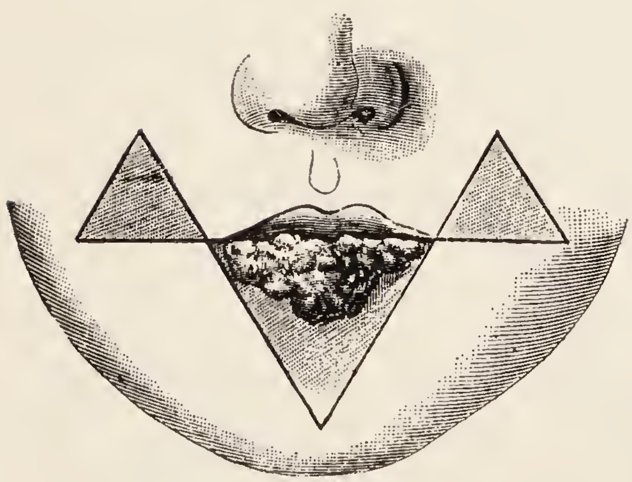


FIG. 602. FIG. 603.
Brun's cheiloplasty. (*Esmarch and Kowalzig.*)



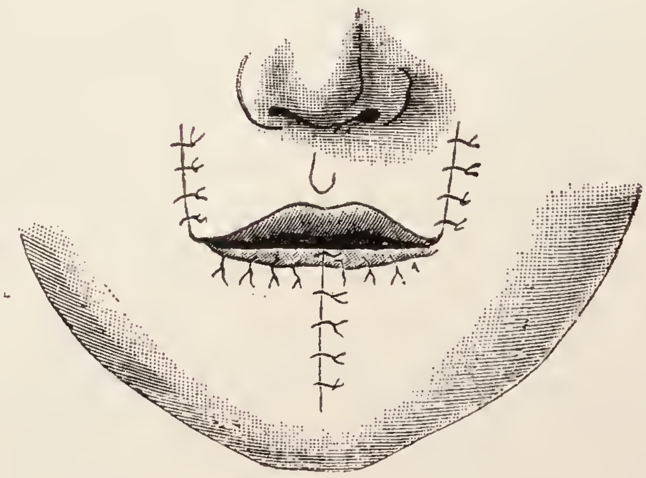


FIG. 604. FIG. 605.
Burow's cheiloplasty. (*Esmarch and Kowalzig.*)

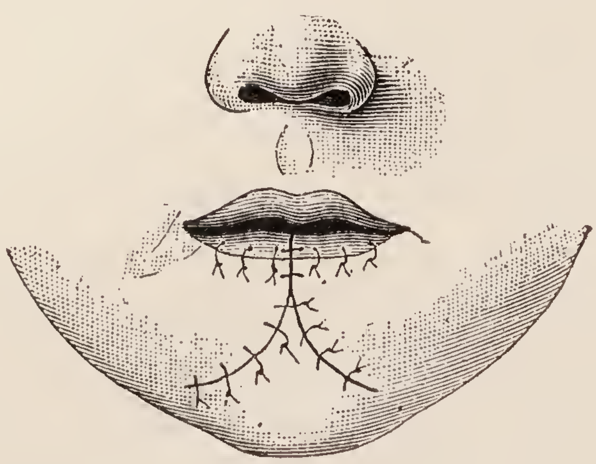


FIG. 606. FIG. 607.
Blasius' cheiloplasty. (*Esmarch and Kowalzig.*)

ing such an operation, it may be necessary to remove a large area of the lip, with considerable deformity. The defect may be overcome only by supplying the deficiency by transferring tissues from the adjacent parts (Figs. 596 to 607, inclusive).

If a tumor occupies one-half the lower lip, its removal will contract the mouth, causing a retraction of the under lip, while the protrusion of the upper lip is like the extension of the beak of the parrot. Such a deformity requires correction. This may be done by making an incision from the angle of the mouth outward (Figs. 608 and 609). These incisions should be carried through the entire thickness of the cheek, far enough to produce a mouth of normal length from angle to angle and a little beyond, as the healing of the parts is always followed by some contraction. Then the mucous membrane should be dissected up, carried outward and accurately fixed to the border of the skin with horsehair sutures.

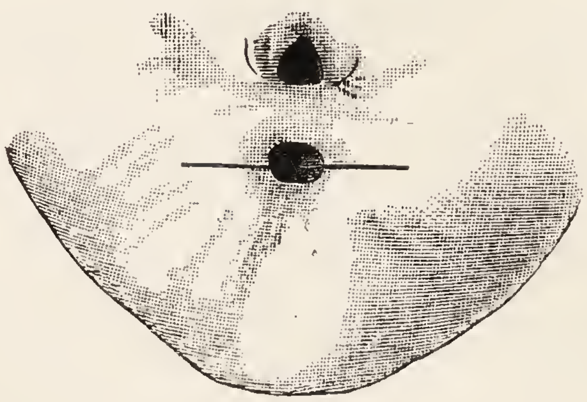


FIG. 608.

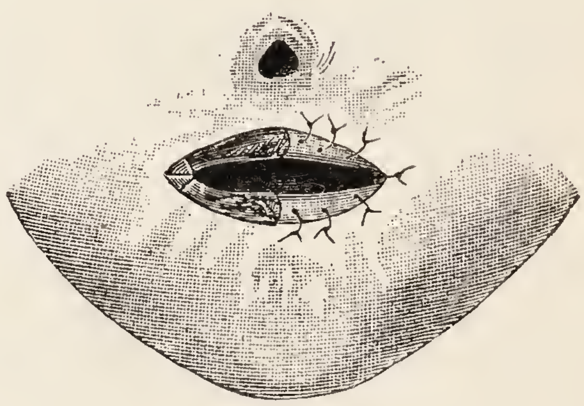


FIG. 609.

Dieffenbach's stomatoplasty. (Plastic surgery of the mouth.) (*Esmarch and Kowalzig.*)

Suture Material Used.—Dieffenbach's stomatoplasty has furnished the foundation for higher achievements in the plastic surgery of the mouth and face, which has been greatly improved by the introduction of horsehair sutures. The great advantage of these sutures over silk or any other material that is capable of absorbing the secretions has been referred to elsewhere in this work. They should be introduced with fine Hagedorn needles and, after the parts are carefully approximated, union by first intention may be expected and no suture scars or marks will remain. Silk sutures, though paraffined, or saturated with gutta percha or wax, may absorb and retain the secretions, become centers of infection and leave permanent scar tissue. Silkworm gut is too stiff and wiry to serve the purpose in delicate manipulations upon the skin and mucous membrane, while all other sutures are open to objections which cannot be raised against horsehair.

Other Methods of Reconstructing Lower Lip.—Von Langenbach removed a flap of sufficient thickness from the middle of the chin to form the entire lower lip. A superabundance of tissue should thus be removed, since the contraction of the fresh surface not covered with mucous membrane must draw the lip to one side and produce an irregular mouth. This may

be overcome in a measure by removing a flap of mucous membrane from the cheek and carrying it over the freshened surface of the flap which is to form the lip.

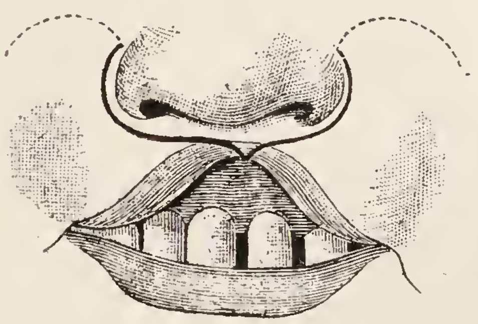
In the construction of a lower lip or extensive defects of the lower lip, Kawalzig Morgan, in 1829, employed the skin beneath the chin. He made an incision along the border of the mandible and reflected the tissues upward (Figs. 610 and 611). This tissue was stitched in place and the wound below

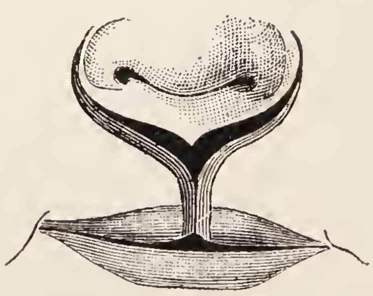
Fig. 610. Fig. 611.

Morgan's chelioplasty. (*Esmarch and Kowalzig.*)

was permitted to heal by granulation or by skin grafting. This wound may be closed by making use of a V-shaped incision beneath it, which makes the approximation of the skin over the open space quite easy. (The author's course.)

Upper Lip.—The upper lip may be reproduced either by sliding lateral tissue into proximity or by making flaps. The operation of Dieffenbach consists in making an incision of the alæ of the nose high enough to secure





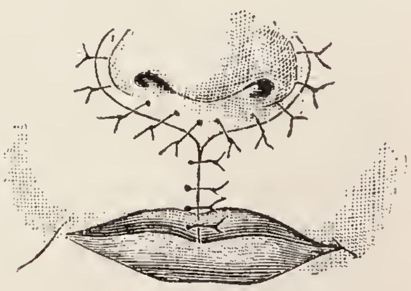
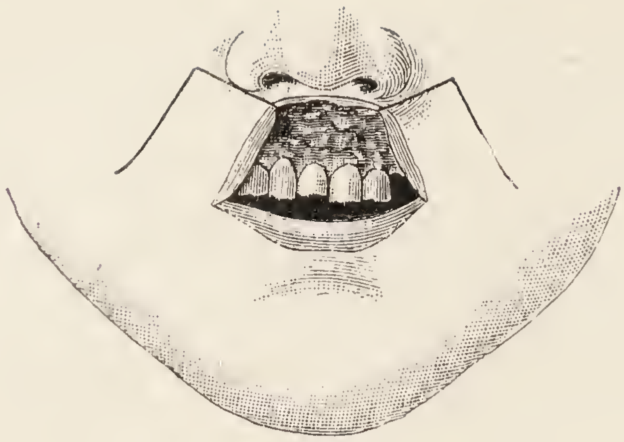


Fig. 612. Fig. 613. Fig. 614.

Dieffenbach's sinuous incision. (*Esmarch and Kowalzig.*)

sufficient tissue to form the lip (Figs. 612 and 613). These tissues are lifted away from the attachment of the periosteum and carried downward and toward the median line, where they are united (Fig. 614). In cases in which the lip has in it about one-half the tissue, Nelaton's operation for harelip (see page 621) will produce a very satisfactory result. In Dieffenbach's operation, if the flaps do not meet easily, a curved incision may be made outward from the upper extremity of the first incision. This will relieve all tension and enable the flaps to be brought easily into proximity



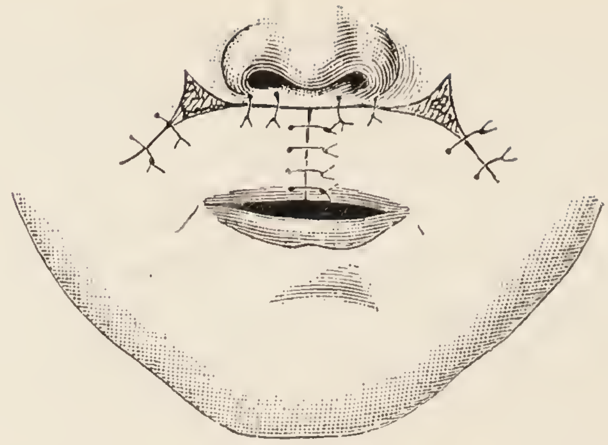
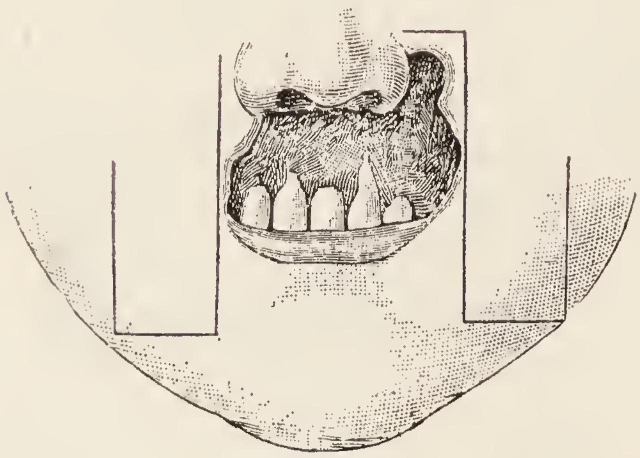


Fig. 615. Fig. 616.

Brun's chieloplasty. (*Esmarch and Kowalzig.*)



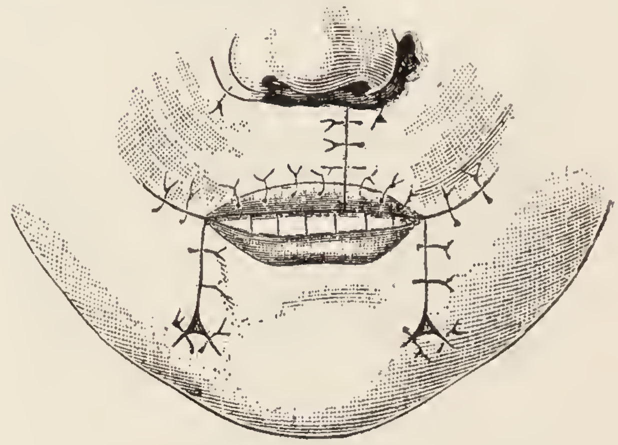
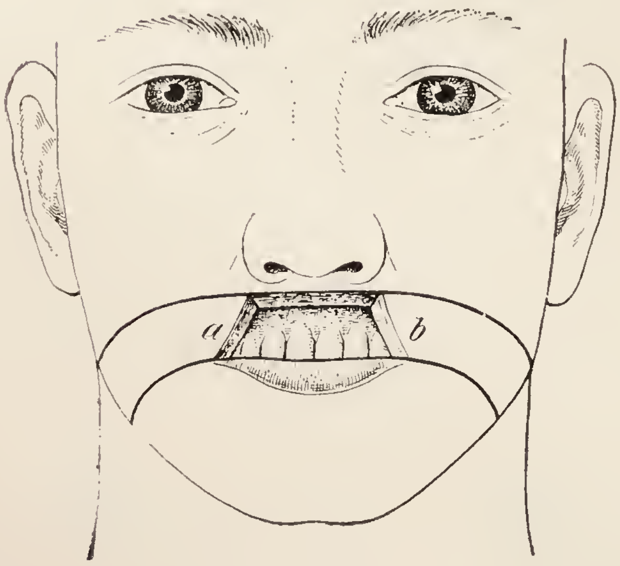


Fig. 617. Fig. 618.

Sedillot's cheiloplasty. (*Esmarch and Kowalzig.*)



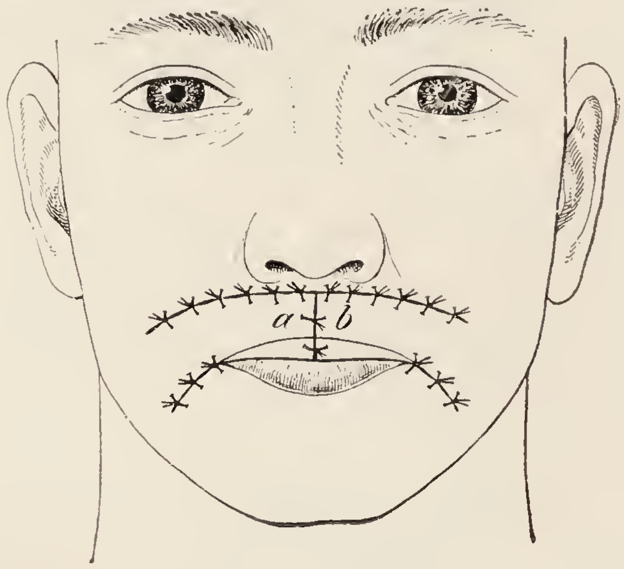
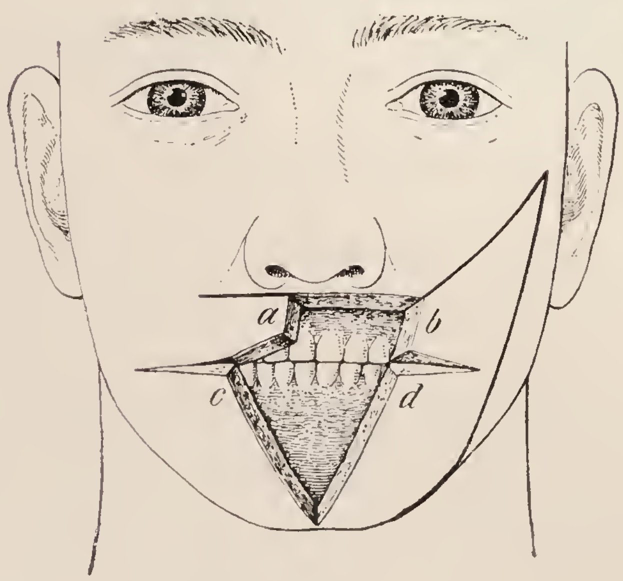


Fig. 619. Fig. 620.

Restoration of upper lip. (*Modified from Szymanowski.*)



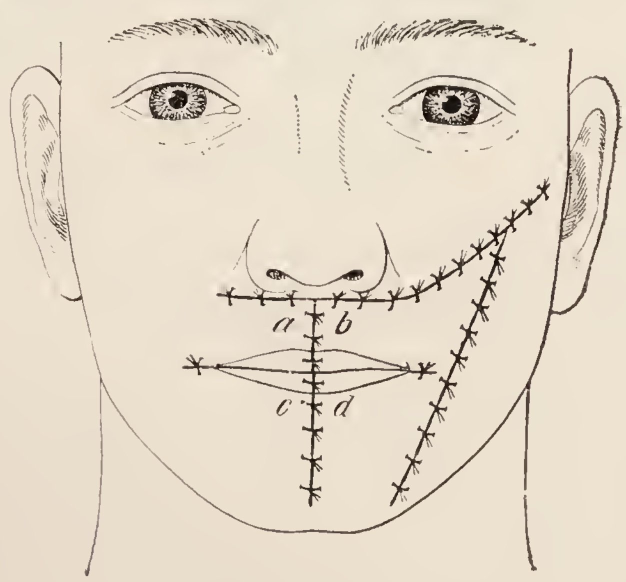


Fig. 621. Fig. 622.

Restoration of both lips. (*After Szymanowski.*)

in the median line. In the absence of the entire upper lip, Brunn's operation—making two lateral flaps from the cheeks—furnishes a very satisfactory solution of the problem of restoring a lip (Figs. 615 and 616).

The plastics of the upper lip devised by Sedillot, though not as desirable as those of Brunn, may, in certain cases, be employed. In this operation

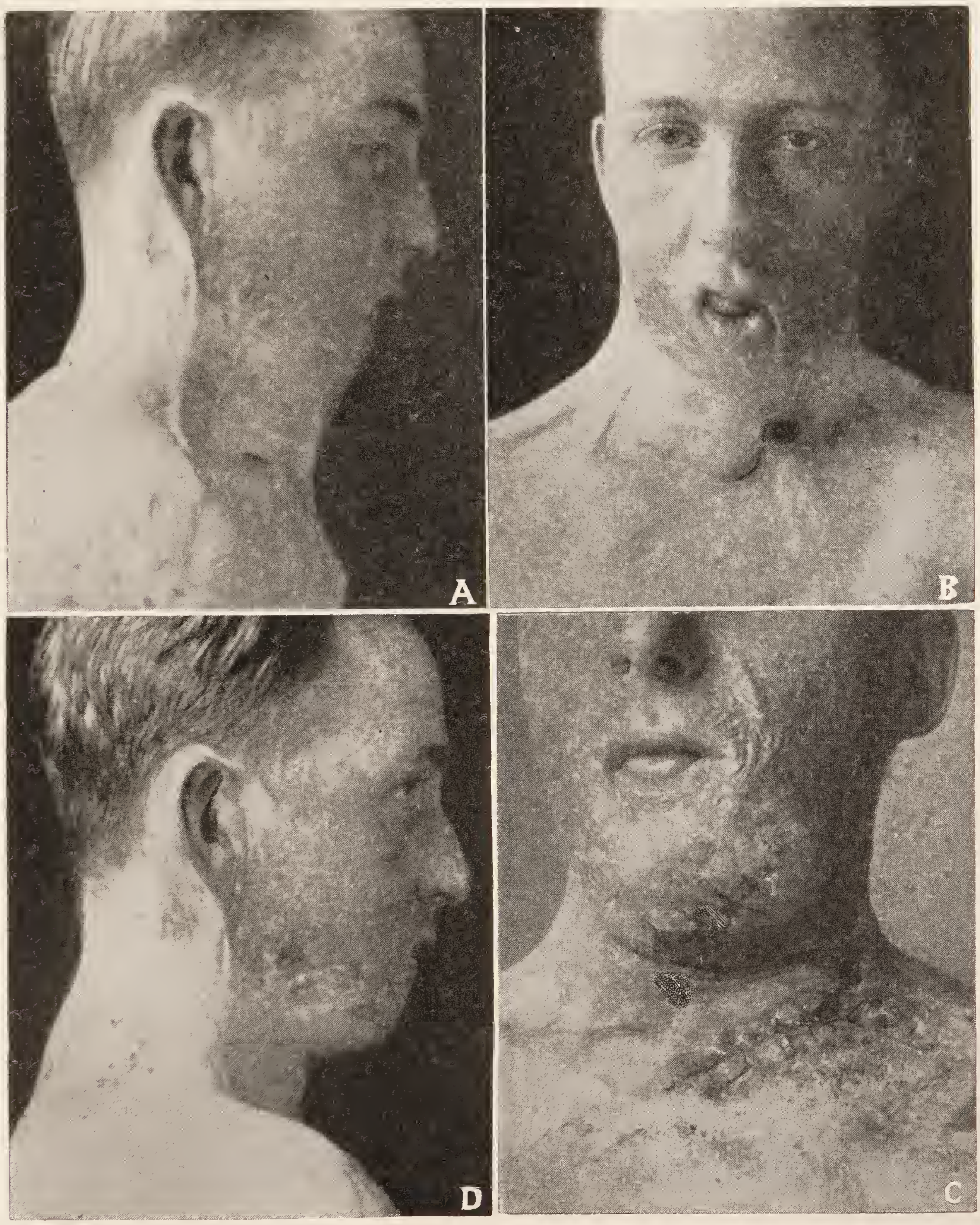


FIG. 623.—Plastic operation on the neck and face for the correction of adhesions following a burn. A. Profile view; B. Front view; C. Flaps with sutures still in place; D. Profile after operation. (*Operated on by Dr Carl Beck.*)

two lateral square flaps are cut from the cheeks, which are carried above the lower lip beneath the nose and approximated in the median line (Figs. 617 and 618).

The restoration of the upper lip by a method modified by Szymanowski, in certain cases, may present features preferable to those previously de-

scribed (Figs. 619 and 620). In Dr. Roberts' work on surgery of the face, the upper and lower lips may both be restored after Szymanowski's method by making incisions as per illustrations (Figs. 621 and 622), lifting the flaps from their attachment to the bone and carrying them to the median line, suturing them as illustrated, and producing the fold of mucous membrane in the lip previously described in this article on the construction of the lower lip.

CHAPTER XXXII

DENTO-ALVEOLITIS

Definition.—Dento-alveolitis means any inflammation involving the dental alveoli and dental alveolar processes. By this term, I designate such conditions as pericementitis, osteitis, so far as it relates to the dental alveolar processes, and periosteitis, etc., inasmuch as the gingiva embrace the necks of the teeth, thus forming part of the dental alveoli, gingivitis is also included. Inflammations involving the tissues here named may suppurate and cause a flow of pus from the tooth sockets. This outflow of pus has been designated by many names, the most common of which is pyorrhea alveolaris. Pyorrhea alveolaris is not a disease. It is the sequela of an inflammation and cannot be regarded, even with the greatest elasticity of scientific nomenclature, as a disease. The inflammation may begin as a result of dento-pulpitis. Its history is frequently associated with the history of dental caries. With the advance of dental caries, the tooth pulp becomes exposed and inflammation of the pulp follows. The pulp loses its vitality, either by gradually sloughing out or by strangulation at the apex of the root. If by strangulation, gangrene of the pulp will result. Following the death of the pulp, its decomposition takes place and it breaks up into the elements of which it is composed. The septic material or the product of decomposition may find its way through the apical foramen and cause an infection of the pericementum. This incipient infection increases from hour to hour until, by and by, an abscess is formed within the alveolus of the infected tooth root (Fig. 624). Each root may thus have an abscess form at its end. Most fortunate it would be if the putrescent pulp were thoroughly removed and the cavity disinfected before the pericementum was invaded by the toxic elements which contain noxious gases and ptomaines.

Any inflammation involving the pericementum or the bony alveoli may, very appropriately, be termed dento-alveolitis. The term "alveolitis" was first proposed, I believe, by the late Professor Nicholas Senn. It is in accord with the general nomenclature of pathology. An inflammation involving the periosteum is known as periosteitis, and so with other membranes; the terms are applied not only to indicate the character of the lesion, but the tissues involved. The abnormal condition, which has been recognized, quite likely, since time immemorial and which has been, in late years, considered under many names, is nothing more nor less than a dento-alveolitis.

Dental Nomenclature.—The commission on nomenclature of the Institute of Dental Pedagogics, in analyzing terms employed in dental literature, has found it necessary to eliminate many that are not desirable. This has been done with a view to literary improvement and advancement. A similar

commission was formed by the American Medical Association. Fortunate it is that commissions were organized for the purpose of reviewing and revising the nomenclature of medicine and dentistry. Dentistry has been burdened by the introduction of indefinite terms, suggested by men who have abandoned the use of more appropriate ones. For example, the term peridental membrane was introduced into dental nomenclature to take the place of the term pericementum, the latter being a term which explicitly named and defined the location and anatomical relation of the membrane to the tooth cementum. It is a membrane, as its name implies, peri = around, and cementum = the cementum of the tooth. The term peridental membrane must mean a membrane surrounding the entire tooth. We know there is no such membrane, save only in embryonal development, in the form of the dental follicle. The commission on dental nomenclature has, therefore, eliminated the term peridental membrane. I trust its use will soon become obsolete.

The Many Names Used.—The many names which have been applied to dento-alveolitis are confusing to the student and to the practitioner. In American dental literature, among the first to describe the condition was Dr. W. J. Younger, formerly of San Francisco, now of Paris. In 1864 he demonstrated the curability of the condition then known as gangrene of the teeth or necrosis of the jaws. Since that time he has been speaking and writing on it in various parts of the world. However, it remained for John Riggs to bring the matter forcibly before the profession, which he did several years later. The condition was, therefore, soon recognized as Riggs' Disease. Later it was described by Dr. F. H. Rehwinkle under the name pyorrhea alveolaris,[1] a name which, while not expressive of the pathology of the condition, has come into common use. Many other names have been suggested by writers on the pathology of dental alveoli and the parts immediately associated therewith, among which are:

Riggs' Disease
Pyorrhea Alveolaris
Suppurative Pericementitis
Phagodenic Pericementitis
Interstitial Gingivitis
Dental Periosteitis
Dento-osteitis
Dento-Alveolar Osteitis
Suppurative Peridentitis
Pericemental Suppuration
Alveolo-dental pyorrhea
Chronic Alveolar Osteomyelitis
Dental Interstitial Arthritis
Phagodenic Pericemental Alveolitis
Alveo-dental Suppuration
Alveolar Osteomyelitis
Dento-socketitis
Hematogenic Calcic Pericementitis.
Peridentitis
Diffused infection of the dental alveoli.
Chronic Septic Alveolitis

Every one of the above is used by authors to describe dento-alveolitis in some of its pathological aspects.

The name, which, while not expressive of the pathology of the parts,

[1] The name was used in France previous to this. It occurs in the first edition of Widel's Pathology (1870), the English translation of which appeared in 1872. (W. E. Boardman.)

but which has, by reason of its general use, fixed itself upon the profession and will probably be used by the public for many years to come, is pyorrhea alveolaris, an expression which simply means the flowing of pus from alveoli. The pus might flow from the alveoli of any of the tissues of the body—the liver, the lungs or any part having alveoli. Pyorrhea alveolaris is a phenomenon, not a disease *per se*. Dento-alveolitis is a disease which may terminate in suppuration. In the event that pus exudes from the dental socket, then there would be a pyorrhea alveolaris denti. An inflammation of the pericementum, a pericementitis from *any cause*, would be an expression of dento-alveolitis.

Cause of Tooth Decay.—The attention of scientists throughout the centuries, in the field of pathology, discovered many facts which led to methods of practice now well established. All the work that was done by distinguished chemists in attempting to account for tooth dissolution, caries —commonly called decay—was swept away and practically forgotten when the great scientist, Dr. W. D. Miller of Berlin, demonstrated to the satisfaction of all the true cause of dental caries. When Miller first discovered that caries of the teeth was of bacteriological origin, his claim was regarded by many with doubt. Further investigation, however, by those eminently qualified to repeat the experiments of Miller, confirmed his findings. Dr. G. V. Black recognized the merit of Miller's work and confirmed his investigations. It is sufficient for our purpose to state that lactic acid, a product of bacteriological action, is the agent that brings about disintegration of the enamel of the tooth and thus establishes the initial lesion of a chain of pathological conditions which may involve the entire organism and terminate the life of the patient.

Pathology.—The tremendous influence exerted upon the human body through the inception of dental caries in a single tooth, unfortunately for mankind, is not generally recognized and appreciated. So, beginning with a little, almost infinitesimal defect in the structure of the enamel, the destructive agent insidiously makes its way. The area of diseased tissue increases and these dense rods of enamel, containing ninety-seven per cent. inorganic matter, the hardest tissue in the body, gradually succumb until the dentin, with its more highly organized structure, is invaded. The inorganic element of the dentin, which consists of about sixty-seven per cent. of its structure, dissolves out leaving the organic matter to succumb later. It is then that the first general indication, usually of marked discomfort, manifests itself. The surface becomes sensitive to the action of heat, cold, and sweet and sour substances. Though the patient may tolerate this, since it is not unbearable, gradually and surely the disease advances. Nature does nothing to repair the injury. The only hope of the patient to arrest further progress of the disease is the skill of the dentist. Without this, a little later the tooth pulp will be exposed followed by congestion and extreme pain. Irritation of the minute vessels entering into the structure

of the pulp exerts pressure upon the nerve filaments therein. The unyielding walls of the tooth canal do not admit of the expansion of the vessel to any great extent, so their pressure upon the nerve filaments which supply the parts causes extreme pain. Thus the soft parts and the tooth pulp become subject to inflammation, and this we technically call pulpitis.

Preserving Teeth.—Prior to the advent of advanced bacteriology, it may be seen by reviewing the literature of the dental profession, spirited discussions were entered into on the subject of capping and preserving alive the exposed dental pulp. In the light of our present knowledge, we know that a tooth pulp, exposed and infected as nearly all of them are after a brief period of exposure, is not amenable to preservation. A tooth pulp, however, which may have become exposed accidentally without infection, may, with the most careful management, be kept and preserved alive. Skilfully handled, a tooth pulp may be removed after it has been anesthetized by cocain, eucain or some other local anesthetic, or it may be completely devitalized by the action of arsenic oxide and subsequently removed. With the tooth canal thoroughly cleansed antiseptically and filled so as to exclude the accumulation of secretions, the cavity in the tooth may then be filled and the tooth restored to health and usefulness. If, however, the patient receives no treatment, the tooth pulp breaks up into the elements of which it is composed, as a result of a suppurative process. The gases of decomposition, hydrogen sulphide and ammonia, may pass through the apical foramen. This is the beginning of an infection, which, under certain conditions, may terminate the life of the patient.

The technic and method of procedure in the preparation of a tooth canal, including the rendering of it aseptic, the introduction of root fillings, etc., are fully discussed in works on operative dentistry, to which the reader is referred. With the present advanced knowledge of dental pathology, it is assumed that a tooth canal is rendered aseptic and properly filled. If so, unless infection of the pericementum has occurred, a tooth thus treated may be made healthy and free from discomfort for an indefinite period of time. The opinions expressed, that a tooth whose pulp has been removed is dead, are not borne out by fact. While the pulp is an essential factor in developing the dentin of the tooth, this pulp may be removed from the tooth of an adult and the tooth preserved in good form many years, as it will be remembered that the cementum of the tooth, surrounded and supplied with nutrition as it is by the pericementum, holds the tooth in vital relation with the circulation so long as the pericementum is adherent to the cementum and walls of the alveoli and maintained in healthy condition.

Harmfulness of Nerve-killing Drugs.—In the preparation of tooth canals for fillings, the application of arsenic oxide, with a view to destroying the vitality of the little remaining portion of tooth pulp, has done much harm by irritating the membranes about the roots, due to its passage through the foramen. Again, the application of cotton dressings of per-

FIG. 624.—Upper incisor tooth showing apical abscess. These abscesses or any irritation to the dental alveoli from any cause whatever will result in dento-alveolitis.

oxide of hydrogen which, by reason of the rapid evolution of oxygen when brought in contact with blood or pus, may force the septic material through the foramen and thus establish infections. Zinc chloride and ninety-five per cent. phenol may, if applied with force, pass through the foramen, come in contact with the pericementum and thus be a source of inflammation. The most damaging of all materials to place in a tooth root is oil of cassia, for this agent will invariably penetrate not only the dentin, but the pericementum and excite an intense pericementitis. Oil of cassia and peroxide of hydrogen, in the treatment of such cases, are contra-indicated. An agent should be used which will not produce irritation. Eucalyptol, oil of cloves, incorporated with iodoform, will serve every purpose. There should not be any excess of the oil to exude from the cotton upon which it is carried into the cavity.

Pericementitis.—An inflammation of the pericementum, a pericementitis, from any cause, is an expression of dento-alveolitis. Among usually assigned causes are the following:

Fig. 625.—Necrotic sequestrum removed from the mandible. The necrosis followed the use of arsenic for the destruction of the dental pulp.

1. Infections resulting from dead and decomposing tooth pulps, and the habitual flora of the tooth surfaces.
2. As a result of extreme pressure made upon a tooth.
3. It may result from a fall, blow or any trauma.
4. It may result from accumulation and retention of particles of food about the necks of the teeth.
5. It may be due to a foreign substance, as a bit of toothpick, toothbrush or coarse, insoluble tooth powder, forced between the neck of the tooth and gum tissue.
6. It may be caused by lead or phosphorus poisoning, or it may be a sequel of mercurial salivation.
7. It may be due to any of the eruptive fevers.
8. It may be caused by irritation established in the adjustment of artificial tooth crowns or badly fitting clasps of artificial dentures.
9. It is frequently due to the accumulation of salivary calculus about the necks of the teeth. These extend down to the alveolar process and become a source of irritation to the soft parts with which they come in contact.

10. It may be the result of any irritant brought in contact with the parts in filling the teeth, or in tooth medication. Arsenic, as applied in the destruction of dental pulps, may accidentally come in contact with the membrane and thus be an exciting cause of the inflammation. Serumnal calculus, so frequently found beneath the pericementum and in contact with the cementum, is not an exciting cause, but a product of inflammation.

11. Excementosis attended with pressure upon the pericementum.

12. Dento-alveolar exostosis and other tumors.

13. In addition to the causes given for the irritation of the pericementum, we may add the application of the rubber dam for the exclusion of moisture while filling the teeth. The pressure of the rubber between the neck of the tooth and the gum, the tying of ligatures high up on the gum, as is often practised, may cause extensive inflammation of the surrounding parts and thus be the exciting cause of dento-alveolitis.

Exciting Causes of Pericementitis.—Pericementitis may be septic or non-septic. Non-septic pericementitis yields promptly to the removal of the cause, which may be undue pressure of a newly adjusted filling, an artificial crown or the wedging of teeth in preparation for a filling. In orthodontial work, non-septic pericementitis is of common occurrence. The application of force in moving teeth and in spreading the arch is an exciting cause of congestion of the pericementum, which may lead to an extensive inflammation. However, the careful orthodontist would not permit his appliances to cause such inflammation. Septic pericementitis is most commonly due to infection resulting from the death and decomposition of tooth pulps. The products of disintegration, heavily laden with pathogenic microorganisms, find their way through the apical foramen, come in contact with the pericementum and infection is thus established.

Symptoms of Pericementitis.—The inception of pericementitis is marked by an itching sensation. The forcing of the teeth together and pressing upon the one affected is rather gratifying to the patient and attended by a sense of satisfaction. A little later, if the congestion increases, contact with the opposite tooth with pressure causes pain. If the congestion further increases, the tooth will be found to be somewhat lifted from its socket due to the thickening of the membrane by its engorgement with blood. The inflammation may involve the surrounding parts and an osteitis or periosteitis may be established. In some instances, as in the upper tooth, the connective tissue of the cheek is involved to such an extent as to close the eye or lift the cheek up on a line with the nose. The swelling may extend back to the ear and produce a most conspicuous disfigurement of the face. This disfigurement may be temporary provided extensive destruction of the bone does not follow. Such an inflammation may well be the cause of great anxiety. It may be arrested in the early stages, but when it has reached the proportions above described, it usually terminates in the formation of a dento-alveolar abscess, with sequelæ marked by complications of

FIG. 625*a*.—Acute dento-alveolar abscess in maxilla which penetrated the antrum and also involved the orbit. (*Oakman.*)

many kinds. To recognize, therefore, the early steps of a pericemental infection and employ appropriate remedies, with a view to arresting its progress, is not only to cure the patient, but to prevent many complications.

The extent of the inflammation is influenced largely by the general condition of the patient. A healthy, vigorous patient, whose powers of resistance are great, is not likely to have an extensive destruction of the bone and soft parts as a result of such an infection. One weakened by disease, such as tuberculosis, syphilis, etc., is more likely to suffer the loss of bone as well as the sloughing away of the soft parts.

Diagnosis of Pericementitis.—In the diagnosis of this condition, a close observation of the morbid changes which take place from the inception of caries of the tooth enamel to the establishment of pericementitis, is essential. In the absence of instruction in medical schools on the diseases and injuries of the teeth, with the many maladies which are dependent upon them for their origin, the average student and practitioner of medicine often misinterprets the pains to which his patients are subject in this region, greatly to the detriment of the patient. The late Professor J. Adams Allen of Rush Medical College, when asked what treatment was good for a certain disease, answered invariably: "It depends on what is the matter." Pain in this region may be due to many causes, and to answer intelligently the question as to treatment, the diagnosis must first be made clear. To undertake the treatment of such diseases without knowing their cause must necessarily result in frequent failure.

Treatment of Pericementitis.—Recognizing the true nature of the disease, an inflammation of the pericementum, our efforts should be directed vigorously toward relieving the excess of blood in the parts. By so doing we reduce the pressure on the surrounding parts, thus relieving the pain. It is fortunate for those who are suffering from this malady that recourse to the extraction of teeth is not always necessary. The advancement of the science and art of dentistry has made it possible, and in the large majority of cases absolutely certain, that pain in a tooth or the tissues surrounding it, usually called toothache (odontalgia), is amenable to treatment.

Obviously, the first step should be directed to the tooth or teeth from which the infection originated. Opening the canal, washing away the contents with a normal salt solution or some mild antiseptic, cleaning the canal and, if need be, puncturing the congested vessels with a sterile broach, thus allowing the excess of blood to escape from the pericementum through the tooth canal, often bring immediate relief. Sinapism or blisters may be employed upon the mucous membrane of the gum over the tooth root about which the pericementum is inflamed. A direct way to relieve the congested blood is to make an opening through the alveolar process direct to the membrane. A local anesthetic may be employed and the membrane thus depleted of excessive blood without great discomfort to the patient. Formerly, leeches were used for this purpose. One may be

placed in a small test tube and applied direct to the mucous membrane covering the congested part.

The application of heat or cold externally may sometimes be used advantageously. The use of cold is not popular because it is difficult to maintain. Cold contracts the blood-vessels and may prevent excessive congestion and inflammation of the tissues. Once suppuration has begun, however, it is contra-indicated. Inasmuch as it is impossible to determine just when suppuration begins, we do not use cold applications. In the early steps of the inflammation, cold may be used advantageously, since the vessels may be contracted and the inflammation terminated by resolution. If suppuration has begun, a dento-alveolar abscess will have developed about the apex of the tooth root.

DENTO-ALVEOLAR ABSCESS

A dento-alveolar abscess is a circumscribed cavity containing pus situated at the apex of the tooth root and depending upon the death of the pulp for its origin. Dento-alveolar abscesses are said to be of two kinds:

Blind abscesses, those without sinuses (Fig. 624).

Open abscesses, with sinuses for the escape of pus (Fig. 632).

An alveolar abscess may be acute or chronic. The pus may form in the tissues near and sometimes about the end of the root in teeth whose pulps are still living, but such instances are extremely rare. I would not designate these as true dento-alveolar abscesses. A true dento-alveolar abscess, therefore, must have its origin in the tooth and be due to the death of the dental pulp.

Symptoms.—The signs and symptoms of a dento-alveolar abscess are outlined in the primary steps of the condition described as pericementitis. The termination of pericementitis in the formation of pus and in the development of the abscess will not be considered. A careful examination of the mouth should be made, using an exploring instrument and a mouth mirror. The teeth should be thoroughly inspected and the tooth about whose root ends the abscess is formed should be located and its condition noted. Such a tooth is lifted a little further from its socket than is seen in the case of acute pericementitis. The pus dissects the membrane away from its bony wall, thus accounting for its further displacement.

A dento-alveolar abscess may be attended by extensive swelling (Figs. 626 and 627), as previously described in the consideration of pericementitis. The abscess involves the bone to the extent of the size of the cavity (Figs. 628 to 631).

The pus will usually escape through the surface that affords the least resistance. It may form a definite sinus through which the pus discharges, or it may penetrate the bone, most frequently the external alveolar plate, lift up the periosteum for a considerable distance, thus denuding the bone, and finally escape through a sinus at some point quite remote from the place of origin.

Following this, necrosis of the bone may occur. The pus may escape in any of the following ways:

1. It may escape through the lingual surface and form a sinus at some point not easily observed (Fig. 632). If in the upper jaw, the pus may find its way into the nose (Fig. 633), become a source of irritation and be easily mistaken by the rhinologist for suppurative catarrh of the nasal membrane or empyema of the antrum.

2. It may escape through the tuberosity of the bone into the pharynx and this opening may not be discovered. Again, a catarrhal condition of the pharynx may be treated indefinitely, without a knowledge on the part of the physician of the real character of the disease, unless he has become well acquainted with the condition of the patient's teeth.

Fig. 626.—Extensive swelling of the cheek, due to dento-alveolitis.

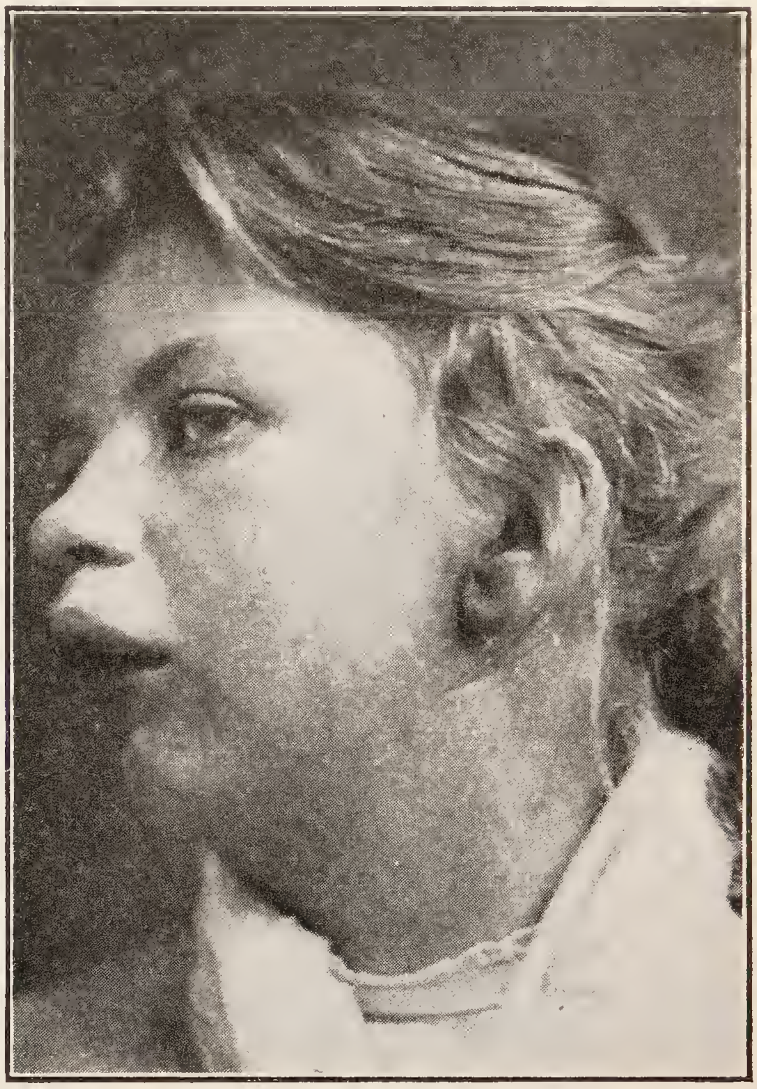


Fig. 627.—Extensive swelling of the lip due to dento-alveolitis.

3. The pus may escape through the floor of the orbit and form a sinus upon the cheek, greatly to the inconvenience of the patient and the confusion of the surgeon (Fig. 634).

Dr. Upson of Cleveland describes paralysis of the nerves supplying the eye as the result of infections from the teeth.

4. It may find its way through the antrum of Highmore, thus creating an infection of the membranes and establishing empyema of the antrum. (See Diseases of Antrum.)

5. It may pass directly through the external alveolar plate and make its exit through the cheek, forming a sinus (Fig. 635).

6. It may discharge between the tooth root and its socket (Fig. 636), flowing copiously from about the neck of the tooth. This might easily be mistaken for an infection of the membranes covering the septa of bone between the teeth.

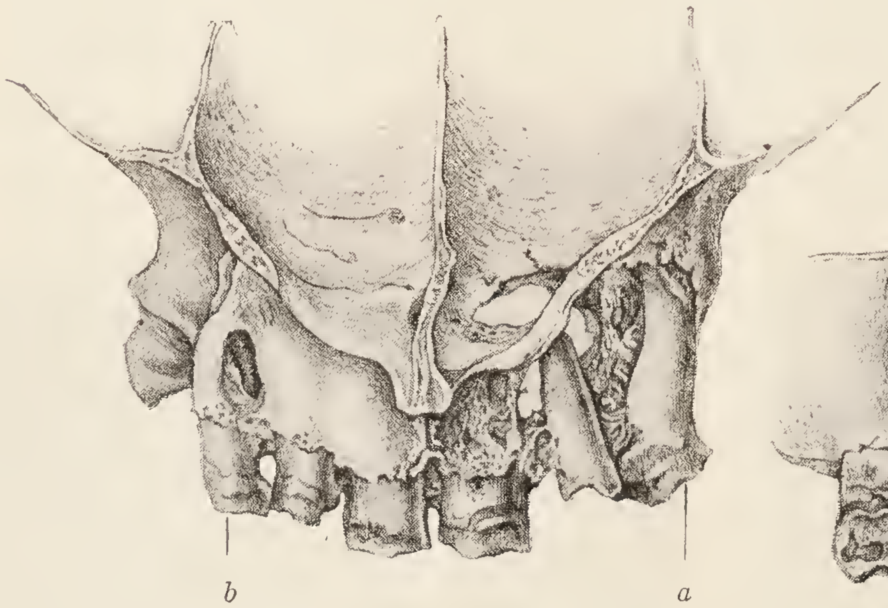


FIG. 628.

FIG. 629.

FIG. 628.—Large hole in the maxilla caused by an abscess around the left lateral incisor. The crown of this incisor was destroyed by caries. The alveolar processes of the lateral incisor and the canine (*a*) are very much eroded. The abscess eroded the bottom of the nasal cavity on one side. Many of the other teeth are badly worn and affected with caries. *b*, Hole in the alveolar process, the result of an abscess. (*Heider.*)

FIG. 629.—Cavity produced by an abscess of the right posterior bicuspid in the maxilla. Several other teeth are badly affected with caries. (*Heider.*)

FIG. 630.

FIG. 631.

FIG. 630.—Cavity produced in the maxilla by an abscess at the end of the root of the left central incisor. The crown has been destroyed by caries and the canal of the root is open. The external wall of the alveolus is wanting. (*Heider.*)

FIG. 631.—Cavity on the palatal surface of the maxilla caused by an abscess. The ends of the roots of both incisors project into the cavity. The crown of the central incisor has been destroyed by caries. (*Heider.*)

7. In the formation of dento-alveolar abscesses at the apices of roots of the teeth of the mandible, the pus usually makes its exit through the external alveolar plate and mucous membrane opposite the apex of the root affected (Fig. 637). It may, however, take an inward course and discharge on the lingual surface (Fig. 632).

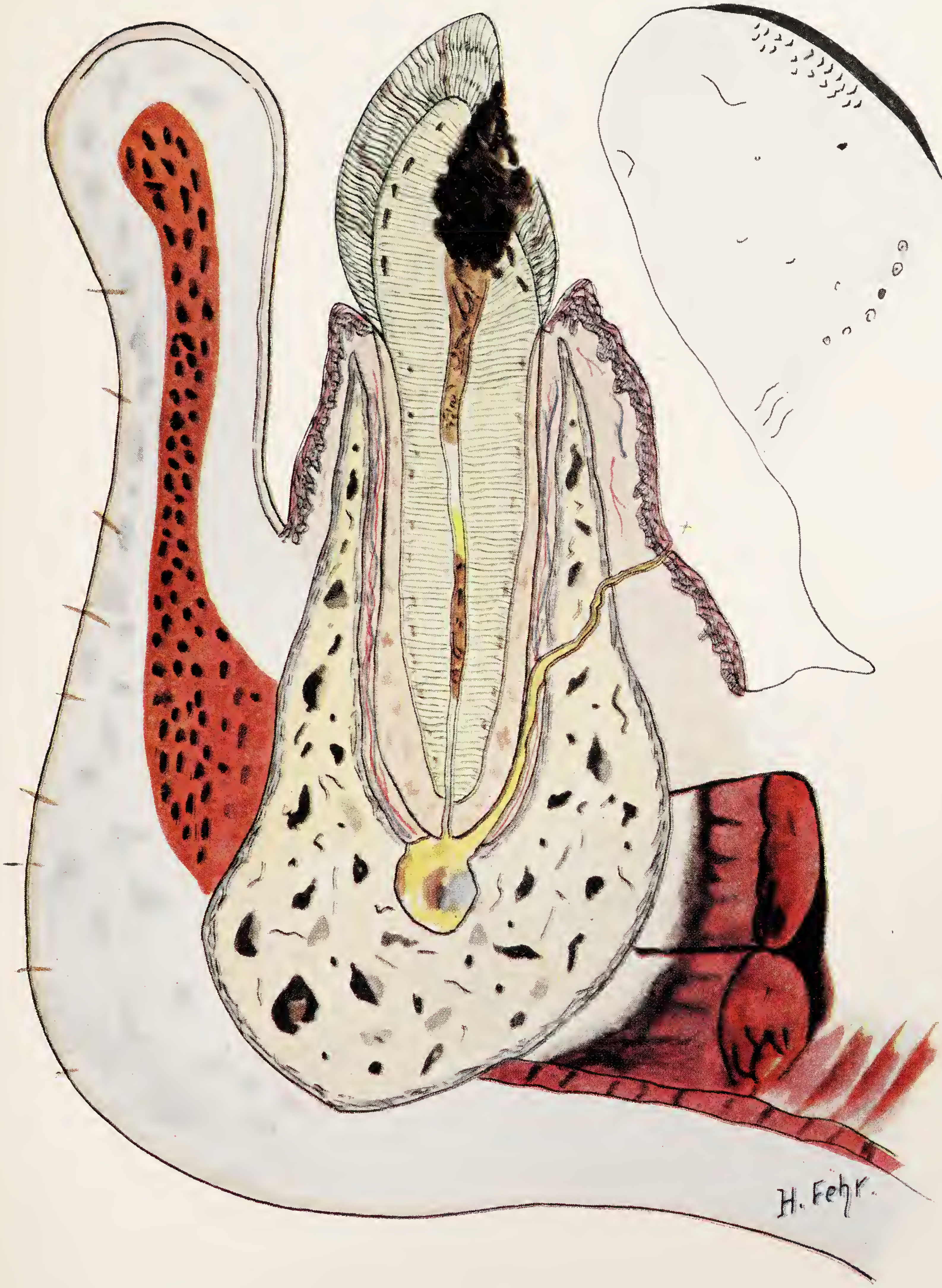


FIG. 632.—Lower cuspid tooth showing chronic dento-alveolar abscess, discharging under the tongue.

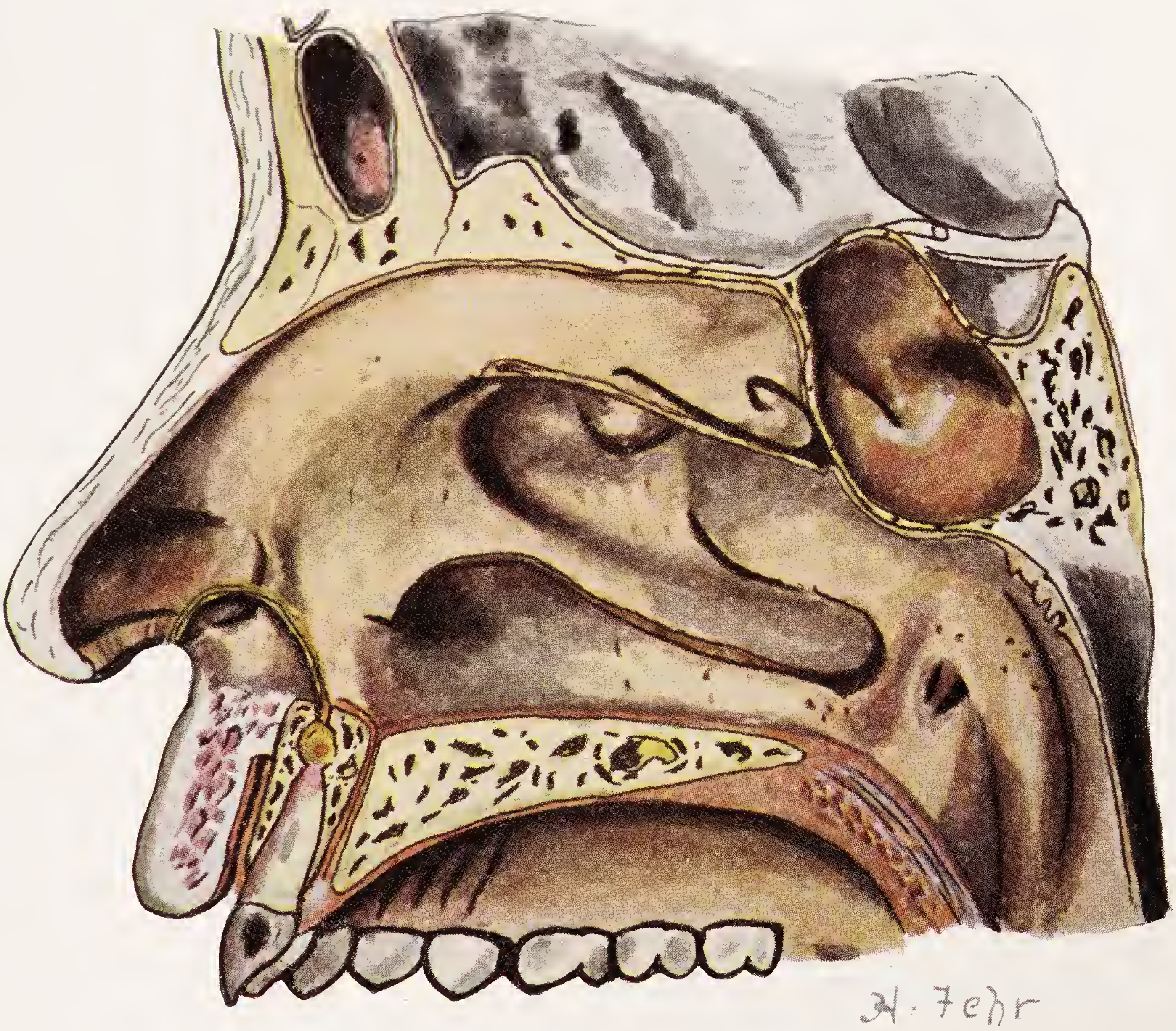


FIG. 633.—Dento-alveolar abscess at the root of an upper incisor tooth discharging into the nose.

8. It may burrow through the soft parts and make its exit through the cheek, opposite the lower border of the bone (Figs. 638 and 639).

9. It may pass backward and discharge through the cheek at the angle of the jaw (Fig. 640).

10. It may perforate the mandibular canal, thus becoming a source of irritation to the nerve and excite intense neuralgic pain.

11. If involving the lower anterior teeth, it may pass through the external plate of the bone and then burrow its way downward to the symphysis and make its exit through the soft parts beneath the chin (Figs. 641 and 642).

12. It may pass directly downward through the substance of the bone, penetrating the lower border and make its exit beneath the chin, in some instances passing along the surface of the skin and discharging at any point between the chin and clavicle (Fig. 643).

Fig. 634.—Abscess of an upper cuspid tooth discharging through the bone just beneath the orbit and upon the cheek.

13. An abscess, involving the second molar tooth, may burrow through the soft parts and find an exit as low as the nipple on the affected side. Fig. 644 illustrates an extreme case, in which the pus from the abscess of a second molar tooth burrowed through the tissues downward, passed over the clavicle and down upon the sternum where the tissue was disintegrated by the infection, and in which bismuth paste was injected by introducing it into the socket from which the tooth was extracted. It may be seen clearly that a large area of the sternum was involved by the destructive process having origin from a dento-alveolar abscess. I am indebted to Dr. Deichmiller of Los Angeles, California, for the use of this valuable skiagraph of one of his patients.

14. The pus may perforate the lingual surface and accumulate in large

quantities beneath the tongue, simulating in appearance a ranula or aneurism. In such cases a careful investigation should be made of the conditions of the cavity by the use of an exploring needle, and the true nature of the fluid determined.

A dento-alveolar abscess is not infrequently attended by marked systemic disturbances. The patient may be subject to a chill, suggestive of general sepsis and the temperature may rise to 103° F. The bowels become constipated, the tongue heavily coated and severe pains are felt in the head. General infection may involve the entire bone and extend to parts beyond. Sepsis may be so extensive as to terminate life. The sequelæ of dento-alveolar abscess, so far as it affects the osseous tissue, is fully considered in the chapter on Caries and Necrosis of Bone.

In a paper recently read by Doctor Gilmer, he makes the following statement relative to the bacteria found in dento-alveolar abscesses. "The following is the report of the cultures made for me by Doctor Moody at

Fig. 636.—Skiagraph showing abscess at the apex of a molar root. The abscess discharges itself between the neck of the root and the gums.

the St. Luke's laboratories. He says 'The pus removed from fourteen cases of jaw abscesses, with two exceptions, was examined in the following routine way: Slants of blood agar and ascites dextrose agar were smeared with the suspected material. One-half of the slants thus inoculated were placed under anaërobic conditions by the addition of pyrogallic acid and sodium hydroxide to the tubes after the cotton plugs had been pushed in about one-third distance from the top. The tubes were then plugged with a plain cork and sealed with paraffin. All cultures were then placed in the incubator at 37° C. where they remained for twenty-four to forty-eight hours.

The tubes under anaërobic conditions were not opened for forty-eight hours after inoculation. At the end of that time smears were made on glass slides and stained in the usual way for the microscopical identification of the organisms.

From this short series of fourteen cases *streptococcus pyogenes* and *bacillus fusiformis* were the predominating organisms. The finding of an occasional staphylococcus pyogenes albus colony, or that of the micro-

FIG. 635.—Alveolar abscess discharging on the face, leaving an unsightly scar.

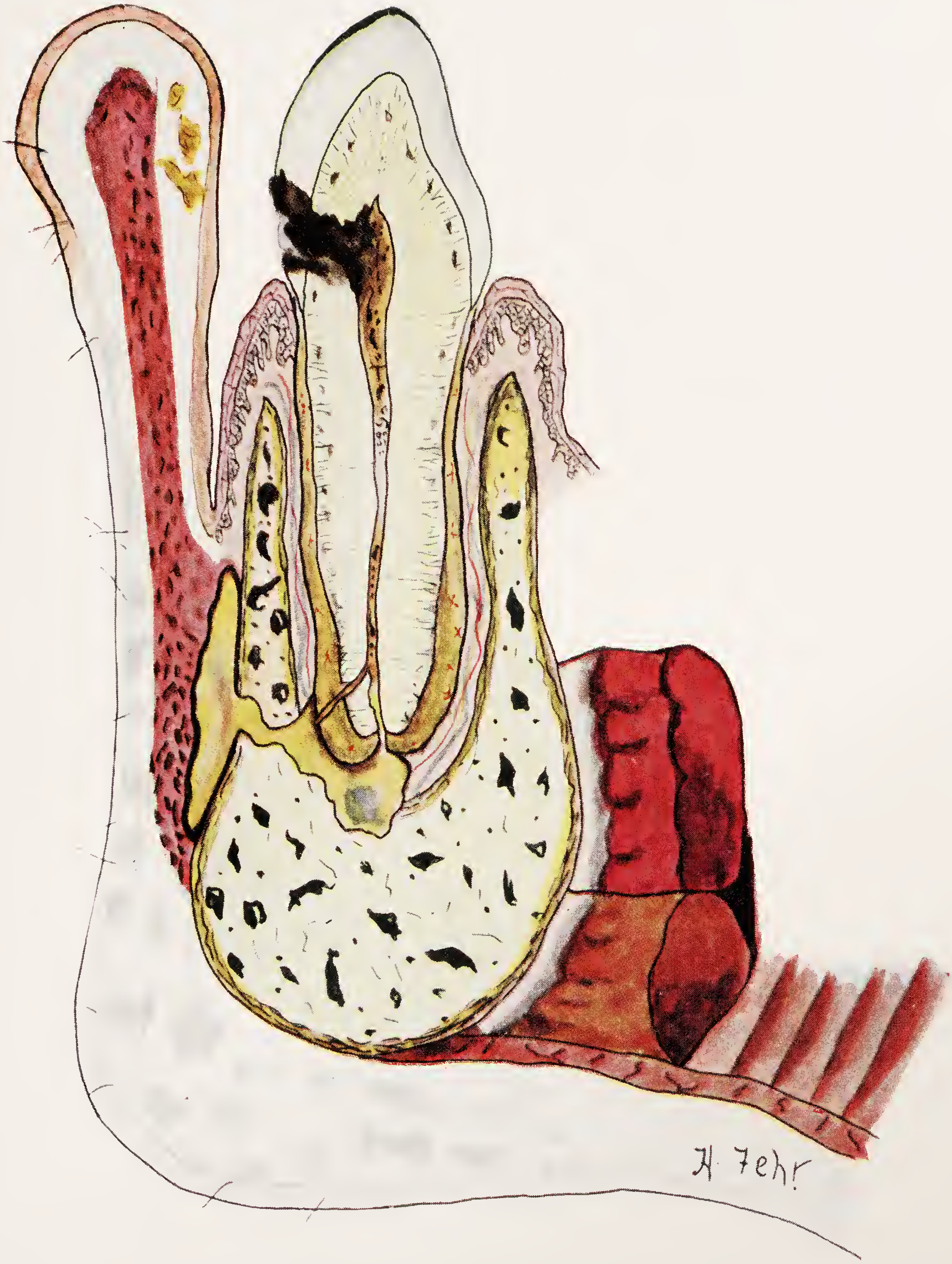


FIG. 637.—Acute alveolar abscess of a lower cuspid tooth with pus cavity between the bone and periosteum.

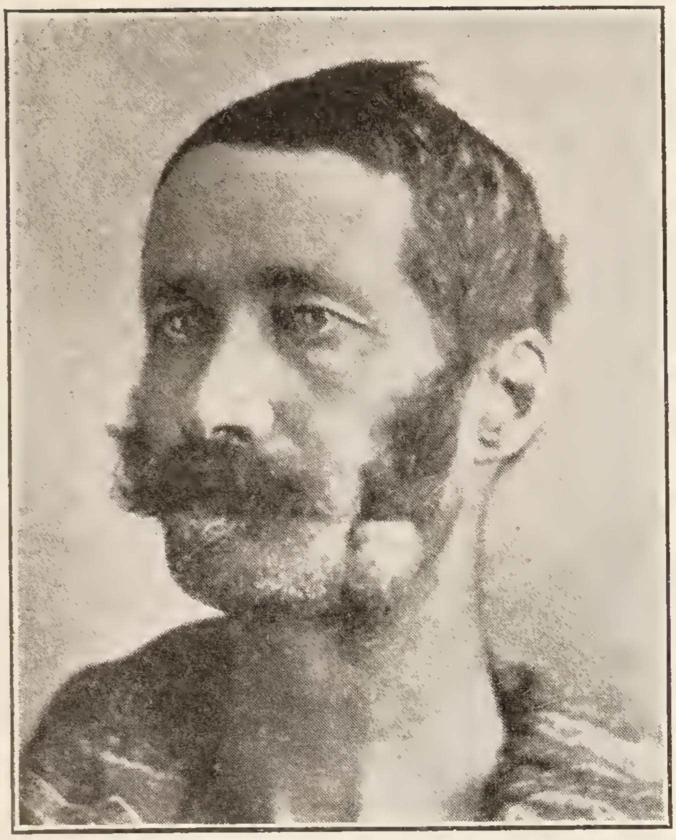


FIG. 638.

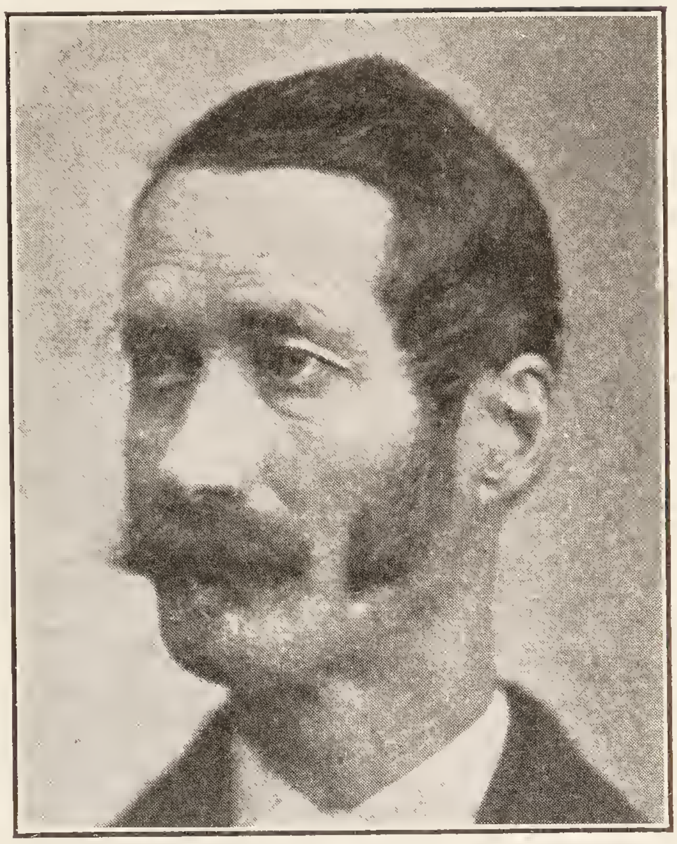


FIG. 639.

FIG. 638.—A dento-alveolar abscess of a lower molar in which the pus made an exit through the external alveolar plate, a large fluctuating mass was formed beneath the skin. A sinus soon formed through which pus discharged externally.

FIG. 639.—The same patient after the abscess was cured. An incision was made intra-orally along the external alveolar plate and the pulp chamber opened and thoroughly cleansed. The roots were filled. The source of infection having been removed, the abscess healed.

FIG. 640.—Abscess discharging through skin at the angle of jaw. This was the result of poulticing the abscess. The mandible had to be removed for necrosis. (*Oakman.*)

coccus catarrhalis we believe to be accidental contaminations. Of these cases streptococcus pyogenes was found in pure cultures in five cases. It was also present associated with bacillus fusiformis in eight cases. B. fusiformis was found in only one case in which no streptococci were found. In two of the cases B. fusiformis was isolated in almost pure culture, there being associated only a few colonies of streptococci. Anaërobic cultures were not made on two cases in which streptococci were the only organisms isolated.

Our conclusions must then be that in this series the predominating organism is a hemolytic streptococcus. In the majority of cases, B. fusiformis is associated with it and often may occur as the prime causative factor in those conditions.'"

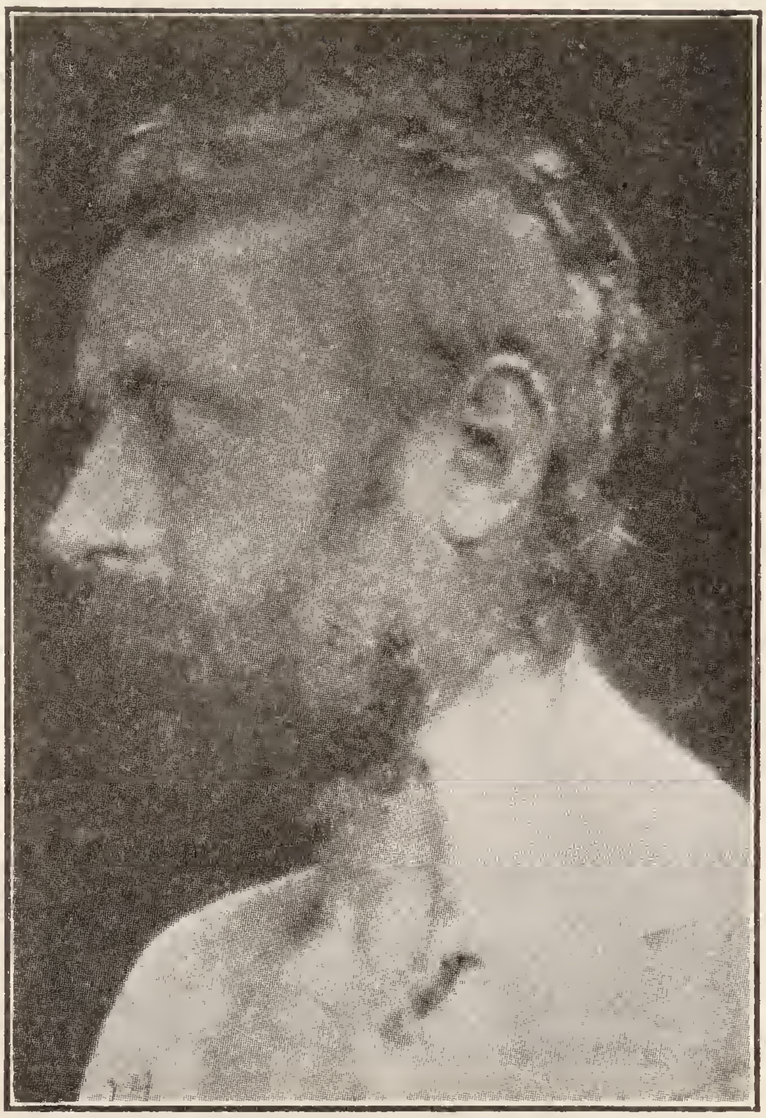


FIG. 643.—Abscess of the third molar with a fistula opening in the sternal region. (*Schröder.*)

Treatment.—While dento-alveolar abscess is not a disease of the tooth it is, however, one which had its inception in a tooth. The treatment of dento-alveolar abscess consists in following out the general principles underlying the treatment of abscesses anywhere. It is not based upon the removal of the tooth, a practice which, I trust, may soon become obsolete with all intelligent practitioners, as well as with the laity, but upon getting access to the cavity itself, draining the pus and making use of agents to restore the parts to health. Osteomyelitis of the tibia is not based upon amputa-

FIG. 641.—Lower tooth showing chronic dento-alveolar abscess, discharging on the face under the chin. The pus sometimes passes directly through the substance of the mandible discharging immediately beneath the chin.

H. Fehr.

FIG. 642.—Dento-alveolar abscess discharging above the thyroid cartilage. Such sinuses are always misleading. They may discharge direct from the glands or from infection of the bone but more frequently dental abscesses.

tion of the leg. As in the treatment of the bone, the pus cavity should be opened, drainage effected and the patient cured without sacrificing healthy, useful tissue. This can best be done by the use of the dental engine, making an opening into the tooth sufficiently large to insure access to the canal, or

FIG. 644.—A sinus leading from the infected first right inferior molar through the external plate of the bone beneath the skin to a point in the sternum opposite the third rib. Bismuth paste shows the tract of the sinus and also a large carious cavity in the sternum. (*Deichnieller.*)

canals in teeth with two or more roots. The canals may then be thoroughly irrigated and a fine sterile broach should be passed into them so that the abscessed cavity may be thoroughly evacuated. The aim should be to remove the gangrenous dental pulp, the origin of the infection of the membrane,

and also to remove the pathogenic micro-organisms which inhabit the cavity. In uncomplicated cases, or those in which there has not been considerable caries of bone, this treatment will effect a cure. External incisions are not

Fig. 645.—Scar from tooth abscess. Excision followed by paraffine injection and implantation. (*Eckstein.*)

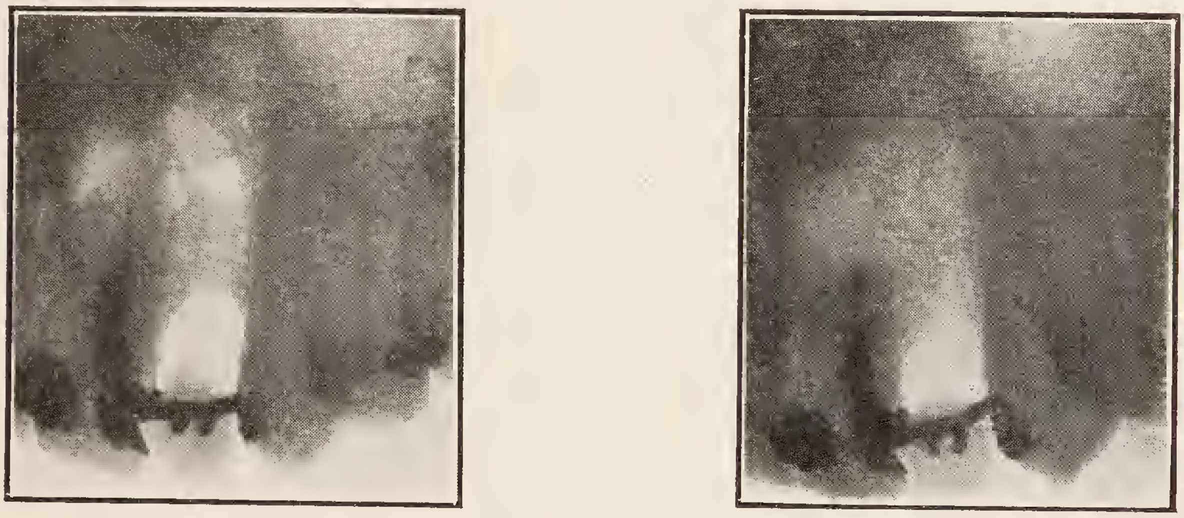
called for in the treatment of dento-alveolar abscesses. Fig. 645 shows the result of such treatment.

Should the abscess have origin from a tooth which may be treated and successfully filled, or if it arises from a tooth of sufficient firmness in its socket to support an artificial crown, it is plain that such a tooth should

be preserved. If, however, a tooth root is hopeless, loose in its socket or fractured in such a way as to make its retention impracticable, it should be extracted. In the chapter on the Extraction of Teeth, I have pointed out the conditions which call for extraction.

If a sinus is formed, a mild antiseptic may be carried through the canal into the cavity and out of the sinus, thus freeing it of its septic contents. The use of ninety-five per cent. phenol was formerly largely employed in the treatment of simple dento-alveolar abscesses with sinuses, but more recently milder agents have been used with greater satisfaction. It is not wise, in treating a blind abscess, to force fluids into it. If done at all, it should be with extreme care so as to prevent forcing the infection beyond the diseased area.

It should be a practice when, by palpation, the pus is found to be lying beneath the membrane, to evacuate it by making a liberal intra-oral in-



A *B*

Fig. 646.—Apical abscess on central tooth of long standing, necessitating amputation of the root.

cision. Too frequently such incisions are not long enough and not deep enough to thoroughly remove the contents of the cavity. Usually if the abscess is complicated by caries of the bone it will not respond to the treatment indicated above. The depression left after the sinus heals may be removed by loosening the adhesions and filling out with paraffin (Fig. 645). In such cases amputation of the involved roots is necessary together with the diseased bone surrounding the root (Fig. 646).

Dento-alveolar abscesses, in their relation to infection of the antrum of Highmore and the nasal passages, are fully considered in the chapter on Diseases of the Antrum. The illustrations which accompany this chapter convey clearly to the mind of the reader various phases of dento-alveolar abscesses. It should be understood that such abscesses do not always call for the extraction of teeth. Only worthless roots and sometimes third molars when badly carious should be removed. The extraction of teeth after the formation of a dental abscess unquestionably often develops an extensive sepsis. The freshened surface of the tooth socket

freely opens access to the circulation. Absorption of the septic material may quickly follow, with chills and a rise in temperature, followed by coma and death. If circumstances call for the extraction of the tooth, the greatest care should be exercised in disinfecting the socket and keeping it clean until the infection terminates and the abscess heals.

Pericemental Abscesses.—Many authors hold that pericemental abscesses are always dependent upon the death of the dental pulp. Abscesses may form in the dental alveoli between the apex of the root and the gingival border of the bone, due to an infection which may have gained an entrance about the neck of the tooth or from some other source, as serumal calculus. They may occur without the death of the dental pulp. Such abscesses are usually amenable to successful treatment by evacuation and antiseptic cleanliness. It is necessary to make a free, liberal opening, largely exposing the abscessed cavity, irrigating it thoroughly, thus displacing the pus, and within forty-eight hours, if it does not give evidence of prompt healing, to bathe the interior of the cavity with tincture of iodin. If the bone is not carious, one or two applications of iodin will effect a cure.

If, however, the abscess has become chronic and the bone is involved, fine curettes (Fig. 647) should be employed with which to remove thoroughly

Fig. 647.—Fine curette used for scraping bone in dento-alveolitis.

all carious or necrotic tissue. It is essential, in the treatment of such a condition, to maintain as wide an opening in the orifice of the wound as possible, so that granulations may fill in from the base to the orifice (Fig. 648).

In the management of such an abscess, as in the treatment of all of the infectious diseases involving the gum tissue, it is essential that the continuity of the border of the gum be not divided. A division of the tissue at this point may lead to a recession and exposure of the neck of the tooth, a defect which cannot be overcome subsequently.

In opening a tooth which has a diseased pulp, we may find it partially broken down and partially living. In that event, it is necessary to devitalize and remove the entire pulp. This may be done by the use of a local anesthetic. The application of a local anesthetic, especially when pressure is employed, may force the septic material through the apical foramen and thus establish a further abnormality, which it is our desire to avoid. The use of peroxide of hydrogen, in cases of this kind, should be avoided, since it forces the septic material through the apical foramen and may cause extensive infection.

In the management of putrescent pulps, Buckley has shown that Cassidy's suggestion of the injection of formaldehyde is a most potent agent for such purposes, when properly used. Inasmuch as it is a powerful

FIG. 648.—Showing preparation for excision of root. Diseased condition caused by dento-alveolar abscess.

irritant Buckley adds cresol, formerly called tri-cresol, in equal parts. He further says "This agent has a tendency to darken when exposed to light. It is recommended that a clear solution be obtained and then kept in an amber-colored bottle. Formaldehyde can be diluted with such other agents as phenol or creosote if, in the latter instance, a small amount of alcohol is added to clear the solution. Cresol, however, is recommended for four principal reasons:

1. It is miscible with the formaldehyde in all proportions, thus making, without the addition to alcohol, a good pharmacal product from which formaldehyde gas is constantly generated.

FIG. 649.—Incorrect method of operating for the treatment of fistulæ resulting from dento-alveolar abscess.

2. It is a good disinfectant, much more powerful than phenol.
3. It possesses an anodyne property which modifies the irritating action of formaldehyde.
4. It acts chemically upon the fatty compounds, thereby disposing to advantage of these substances.

Factors to be Considered.—In the successful treatment of the conditions under consideration, there are three important factors which must be accomplished:

1. Establish asepsis.
2. Prevent recurring sepsis.

3. Preserve or restore the color of the tooth."

Buckley designates this combination of cresol and formaldehyde as formo-cresol. This is destructive to the soft parts and should be applied to the teeth after the rubber dam is adjusted, so that it may not come in contact with the mucous membrane.

The management of pulpless teeth embraces an extensive technic which should be studied in a treatise on operative dentistry, dental pathology and therapeutics.

An acute abscess, in a healthy patient, usually heals within a period of two weeks. With the removal of the septic material and sterilization of the cavity, granulations soon fill up the space made by the abscess and the parts become healthy. In a chronic abscess, which is almost invariably complicated with carious bone and with tooth roots more or less denuded of membrane, medication often fails. Complications of dento-alveolitis with caries of bone are considered in the chapter on Caries and Necrosis of Bone.

DENTO-ALVEOLITIS

Dento-alveolitis, the result of mineral poisoning, is not uncommon. Under the heading of gingivitis, some of these diseases are described. While dento-alveolitis may be secondary to gingivitis, in nearly every case the conditions are intimately associated. Since the gum tissue, in part, forms the alveoli for the teeth, inflammations of the gums may be very appropriately included and considered under the head of dento-alveolitis.

Etiology.—The origin and development of dento-alveolitis has claimed a great deal of attention from dental practitioners. It has, of recent years, attracted the attention of medical men, who recognize in it a source of general infection which depletes the vitality of the patient and becomes a serious obstacle in the way of returning health. According to our present knowledge, the origin of the disease is local irritation and its progress is facilitated by systemic abnormalities. Rhein states that "a large number of practitioners still cling to the idea that all forms of this trouble are purely local in their origin and that a permanent cure can be effected by local means. There is no question that lack of hygienic conditions, with all their attendant unsanitary surroundings, is at times the sole cause for very severe purulent discharges from the alveoli. This condition, which is purely local in origin and requires only local treatment, must be sharply divided from those serious cases where malnutrition and poverty of life-endowing corpuscles play so important a rôle. Consequently, we make two grand divisions:

I. Pyorrhea Simplex[1]—embracing all cases of purely local origin and requiring only local treatment.

[1] In this classification the author has employed "pyorrhea" with a view, no doubt, of conforming to the common usage of the word. In the interest of a high standard of dental nomenclature, the pus-flowing cannot be regarded as a disease and the term, therefore, is inappropriate.

Fig. 650.—Unsightly scar caused by dento-alveolar abscess.

FIG. 651.—Lower lateral tooth showing deposit of salivary calculus, causing inflammation of the gum.

II. Pyorrhea Complex—embracing that larger field of more serious disorders and graver affections. These cases are often spoken of as "true pyorrhea" by some authors, "phagedenic pericementitis" by others, and the very latest addition to our category is "hematogenic calcic pericementitis." All these names have been coined because of the observations of certain peculiar clinical features about the alveoli, ignoring entirely the primary cause in this nutritional disorder.

The plan I have the honor to suggest for your consideration embraces the addition of a modifying word of all forms of pyorrhea alveolaris of the complex variety, this modifying word to be indicative of the etiology of the case in question after a satisfactory diagnosis has been made.

Under Pyorrhea Complex we make the following subdivisions:

A. Those due to nutritional disorders, among which may be especially mentioned:

1. Gout.
2. Diabetes.
3. Chronic rheumatism.
4. Bright's disease.
5. Scurvy.
6. Chlorosis.
7. Anemia.
8. Leukemia.
9. Pregnancy.

B. Those occurring during attacks of acute disease, such as acute infective diseases, among these may be mentioned:

1. Typhoid fever.
2. Tuberculosis.
3. Malaria.
4. Acute rheumatism.
5. Pleurisy.
6. Pericarditis.
7. Syphilis.

C. Those that are due to nervous disorders, among these we might specify:

1. Cerebral diseases.
2. Spinal diseases.
3. Neurasthenia.
4. Hysteria.

D. Those conditions resultant from the toxic effect of certain drugs, such as:

1. Mercury.
2. Lead.
3. Iodin.

E. Called Pyorrhea Sequentia, a condition of diseased pericemental tissue left behind after the primary cause has been cured.

With such a classification as this borne in mind, when a man speaks of "gouty pyorrhea" or "mercurial pyorrhea" or "tuberculous pyorrhea" he is at once clearly understood. The pathology and treatment can then be discussed in a rational manner without the injection of entirely irrelevant matters."

Prior to the work of Dr. Riggs, to whom the profession will ever be indebted for an exhibition of some of the most destructive phases of the disease, little was done by the dental profession to arrest its progress, except to remove the deposits of salivary calculus which formed on the teeth (Fig. 651). These gradually insinuate themselves between the gum and neck of the tooth, often extending to the borders of the alveolar process and causing a destruction of the gum and border of the alveolus.

Treatment.—The treatment employed by the early practitioners, oftentimes without taking into consideration the general health of the patient, as in the treatment of any local disease without an understanding of the physical condition, necessarily resulted in failure to effect a cure in many cases.

Investigation of the pathology of this phase of dento-alveolitis has shown that patients suffering from renal disease, rheumatism, gout, tuberculosis, venereal disease, poisoning from lead, phosphorus, mercury, etc., or the sequelæ of typhoid and other fevers, injudicious general medication, the administration of calomel, all have influence in bringing on or aggravating inflammation of the dental alveoli. The most common cause of inflammation of the pericementum, with the exception of gangrenous pulps, is the deposit of salivary calculus upon the necks of the teeth, which extends to the periosteum, as above described.

Having fully considered the influence of sepsis originating from the putrescent dental pulp upon the pericementum and associated parts, we will dismiss that phase of the infection and deal only with other causes. We have stated that the local irritation from deposits about the necks of the teeth is destructive to the gums, pericementum and alveolar processes, and the inflammation established by this irritant is followed by a flowing of pus with gradual destruction of the parts involved. I would regard this condition in a healthy patient very easy to cure. Any one of the many diseases, however, which have been referred to may be an important factor in increasing the inflammation and render its cure difficult. It is too apparent to require argument that a patient suffering from a systemic disease will not withstand a local irritation in the same manner and recover from its influence as promptly as one in health. A cure is facilitated by the patient's power of resistance.

Too frequently writers have taken up one phase of this disease and formed opinions which they have elaborated to the effect that in one having diabetes

and also dento-alveolitis, the latter must depend upon the former; others finding a patient suffering from gout attribute the dento-alveolitis to the gout; and still others having a patient with rheumatism write extensively with a view to proving that the cause of the dento-alveolitis is rheumatism, and so on. Authors have set forth views in accord with their findings, but in all these cases a local irritation is the real nucleus of the malady and the systemic condition is a concomitant and a serious drawback to a cure.

What is necessary in the management of dento-alveolitis is a full, thorough, searching, accurate diagnosis. **What is the matter with this patient locally and systemically?** Whoever would undertake to treat and cure conditions like these, which often seem to resist all local applications, without having a full and complete diagnosis made, will meet with failure. Under observation of the expert pathologist, with all the modern facilities which the scientific laboratory affords, systemic diseases which interfere with the process of repair, following injuries or irritations in any part of the body, may be recognized and understood.

It has been said by Professor Black that "caries of the teeth is a disease of youth and early life" while dento-alveolitis, independent of the influence of putrescent pulps, though found in nearly all adults, is usually a disease of middle life and beyond; it is due to the destruction of the dental alveoli that a greater number of teeth are lost after middle life than from dental caries. The enormous loss of human teeth by reason of this disease is, in itself, a sufficient reason for careful research into its pathology and the influence the many diseases referred to may exert in hastening the destruction of the dento-alveolar processes. Coupled with this is the even more important reason for investigation, the fact that the purulent secretions resulting from this inflammatory condition make deep inroads upon the vitality of the patient and are destructive to health and life itself.

It is upon the common ground of oral pathology that the medical and dental practitioners are separated. Elsewhere in this work attention has been called to the fact that the dental colleges have not, until within recent years, taught as thoroughly as necessary the subject of general pathology, and it is a well-known fact that medical colleges, with few exceptions, do not teach dental pathology. Consequently, the dentist to whom a patient applies for treatment of diseases associated with the teeth not being well informed regarding the general diseases which may largely influence the local conditions, and the medical practitioner being unacquainted with the pathology of the teeth and failing to recognize them as the origin of diseases in other parts, some quite remote, the real pathology of the condition was not understood by either physician or dentist, very much to the detriment of the patient.

Happily, institutions of medical and dental learning, of recent years, have broadened their curricula so that students of dentistry are now receiv-

ing thorough courses of instruction in general pathology and therapeutics, while medical students are having courses of lectures given covering the diseases of the teeth and associated parts, with special reference to the diseases dependent upon the teeth for their origin. From the foregoing, it will be seen that it is necessary in the treatment of any disease, local or otherwise, to take into consideration the entire body. In the hands of even the most expert manipulators, incrustations extending well down upon the tooth and into the intervening spaces between the roots are removed with the greatest of difficulty. The cure of the disease, however, is dependent upon thoroughness in removing these deposits.

FORMS OF CALCULUS

There are two forms of calculus: salivary calculus (Fig. 652), that which is deposited from the saliva, and serumal calculus (Fig. 653), that which is deposited direct from the blood or serum.

FIG. 652.—Two views of an upper first molar tooth with an enormous deposit of salivary calculus. Specimen from Northwestern University Dental Museum. (*Black.*)

Salivary calculus, technically, is known as odontolithos and popularly called tartar of the teeth. These calcific salts are found in greater quantities on the lingual surfaces of the lower incisor teeth where the saliva is poured into the mouth from Wharton's and Rivinian's ducts, and upon the first upper molar teeth where the saliva is deposited from Stenson's duct, but it may accumulate about the necks of the teeth everywhere. The gradual accumulations of these deposits impinge on the soft parts, extend to the bony alveoli and cause its destruction, during which period the exudate of pus may be profuse.

Serumal calculus may be deposited on the cementum at a point not having direct and open communication with the mouth. It is far more diffi-

cult to make a diagnosis of serumal calculus than of the other form. Both forms, however, may exist in the same case. Serumal calculus is a dark, very hard deposit which may, in some instances, cover the greater portion

FIG. 653.—Ground section of a nodule of serumnal calculus on the cementum. A little of the enamel is shown in the upper right-hand corner of the picture. This illustration gives a good idea of the nodular forms generally found in pus pockets. (*Black.*)

FIG. 654.—Lower incisor and cuspids with deposits of salivary calculus which overlapped the gum tissue. Specimens from Northwestern University Dental Museum. (*Black.*)

of the cementum of the tooth. It intervenes the cementum and the pericementum and interferes with the nutrition of the former. Often it becomes a center of infection from which the pus makes its way between the cement

and membrane and finally discharges into the mouth. From this the surrounding parts become involved, the organic matter of the alveolar process is infected and caries of the bone ensues by reason of the breaking down and loss of the organic substance.

If the disease continues without successful treatment, the destruction of the alveolar processes and the teeth will result. Serumal deposits may develop beneath the gum, on the neck of the tooth, in open communication with the mouth and at the border of the bone, followed by suppuration. These deposits may be limited to a single tooth or they may affect many teeth. Gradually the bone breaks down until the teeth become loose and eventually are exfoliated.

The gum tissue sympathizes with the general inflammation; a marked gingivitis exists; general symptoms of pyemia are manifested in extreme cases, and it exists to some extent in all cases; the patient often becomes

FIG. 655.—Teeth with extensive excementosis (cementomata). Specimen from Northwestern University Dental Museum. (*Black.*)

anemic; the presence of such quantities of pus, much of which passes into the stomach, causes gastritis and constipation, with many of the physical disturbances dependent upon such conditions.

The cause of dento-alveolitis due to the irritation established by large deposits of salivary calculus upon the roots of teeth usually is a lack of oral cleanliness. A predisposing cause of the deposits of serumal calculus is congestion of the pericementum from any cause. Moving the teeth out of the normal position by reason of their irregularity and the constant motion given to them when they are brought in occlusion are, unquestionably, common causes of serumal deposits with all their destructive sequelæ.

The deposits of serumal calculus upon the cement of teeth may occur in the presence of the most scrupulous hygienic precautions and upon teeth which are not carious. The first symptom of this condition is a pericementitis with a characteristic thickening of the membrane and loosening of the tooth with slight elevation from its socket. On examination of the gums congestion may be exhibited about the necks of the teeth, or the gums may be normal. When ocular examination and digital manipulation fail

to reveal the presence of deposits on the teeth, a Röntgen photograph should be secured, which will often distinctly outline the deposits upon the roots of teeth not otherwise defective. The Röntgen photograph, however, does not always reveal the presence of the deposit.

The infection of the pericementum in the vicinity of this irritant, together with the alveolar processes and the separation of the pericementum from the cement of the tooth, is followed by a flow of pus into the mouth between the neck of the tooth and the gum, and this flow of pus from the dental alveoli, which is a sequel of dento-alveolitis, is commonly called pyorrhea alveolaris.

We recognize a form of dento-alveolitis, with destruction of the bony alveoli, in patients upon whose teeth deposits are not to be found. It is this class of patient whose conditions have been regarded as due to uric acid diathesis, nephritis, rheumatism, gout, etc., and it has been claimed that relieving any of these diseases named has brought about the cure of the dento-alveolitis. Experience has taught that dento-alveolitis does not yield promptly to local treatment in patients suffering from these disorders, therefore the general condition should be treated.

Dento-alveolitis, independent of pulpitis and the infections that result from pulp putrescence, will now be considered.

The extra-dental invasion of the pericementum by the pathogenic micro-organism presents symptoms quite different from those previously described when considering infections from the dead or decomposing dental pulp. Elsewhere I have stated that the most common cause of diseases of the pericementum and dental alveolar processes is the accumulation of salivary caculus. Many early practitioners assumed that this deposit of calcareous matter was the sole cause of diseases of the dento-alveolar processes with pus formation and loss of teeth. A better understanding of its pathology, however, has shown that inflammation of the dental alveoli may be established by irritations from other causes. There is no doubt that salivary calculus oftentimes is lightly considered by physicians and dentists. Its influence in causing local destruction should impress both with the great importance of having the teeth thoroughly cleaned at frequent intervals.

Technic.—It is not within the province of this work to outline the technic of the very delicate operation of removing the deposits from the teeth. Such a procedure requires not only a thorough knowledge of the anatomy of the parts, but digital skill and familiarity with the many fine instruments designed for the purpose. There is no operaton in dentistry which requires a higher degree of skill and painstaking care than that of thoroughly removing the closely adhering deposits. The dento-alveolar processes are developed for the purpose of supporting the teeth. When they are subject to extensive inflammation, the parts will gradually break down or be absorbed. It is, therefore, an essential consideration in the cure of dento-alveolitis to discover and remove the cause. Failure in the treatment of

this disease, I believe, has been due chiefly to the want of an understanding of all the pathological factors involved.

To remove the visible deposits alone, in many cases, is not sufficient to effect a cure. A tooth or teeth involved must not be considered alone, but the operator must study the entire denture and he must know the physical condition of his patient. All the means at the command of the diagnostician must be employed and the correct measurement of the patient's physical condition secured. With such knowledge, and a knowledge of the local conditions, the best results in treatment may be obtained. It is in this connection that the expert physician and the expert dentist may meet and use their best judgment and skill in the interest of the patient. The seriousness of this disease, the great loss of teeth which never can be

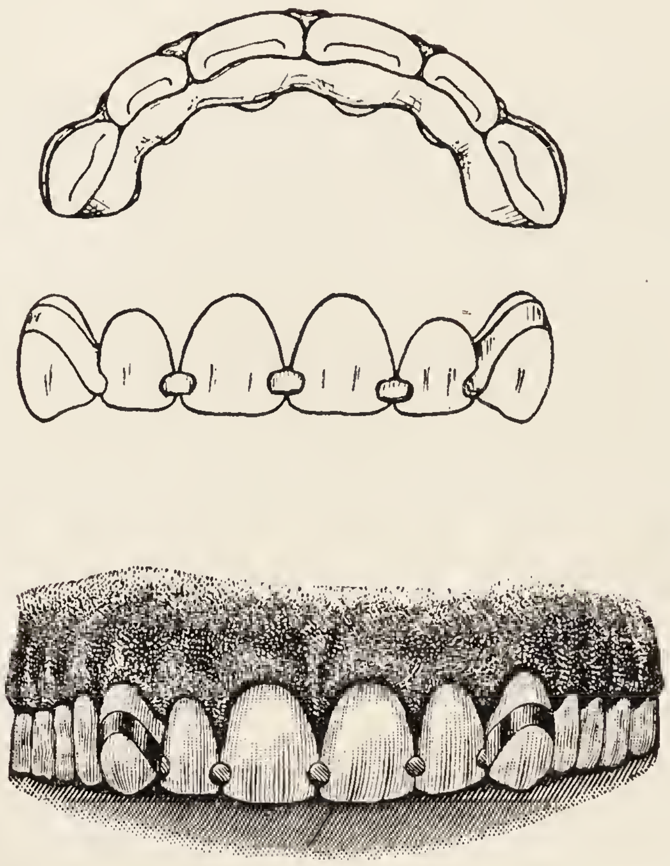


Fig. 656.—Dr. Case's standard retaining appliance, which holds the teeth firmly in place. It is used in dento-alveolitis. (*Case.*)

replaced, call for the highest degree of medical and dental skill to effect a cure.

A principle in medicine and surgery, coming down to us from time immemorial, and which, I think, is often forgotten, is: "When a part is in an abnormal state, put it to rest." There is no condition which calls for rest more than the one under consideration. The dentist who would attempt to correct or cure dento-alveolitis by removing calcic deposits and making injections about the necks of the teeth, when the teeth are irregular and move unnaturally in occlusion, would surely fail. It is essential to correct this unnatural occlusion, to secure correct contact of the teeth, and to overcome the lateral motion which is so frequently observed in patients who are affected with dento-alveolitis.

When normal occlusion of the teeth is established, the most important

step in the treatment of such cases has been taken. Means must be employed then to hold the teeth steady. With appliances constructed and fixed upon the teeth (Figs. 654 and 657); with the deposits thoroughly removed; the necks of the teeth polished smooth; stimulating injections made with a fine, smooth-pointed syringe; attended by most thorough oral cleanliness, we have the most efficient local treatment. The adjusting of appliances, with which to hold the teeth in their proper position and prevent the unnatural movements which always take place when the disease has advanced to a considerable extent, is essential to success in treatment.

FIG. 657.—Dr. Case's band retention appliance. (*Case.*)

A great mistake, which many conscientious dentists have made in their desire to preserve teeth (a most laudable ambition), is in endeavoring to retain teeth whose alveoli have nearly or quite disappeared (Fig. 658). Teeth so loose that there is no hope of their ever being self-supporting may be preserved for a time by successful adjustment of a retention appliance, but the retention of such teeth must be regarded as only a temporary expedient. It is utterly useless to attempt to make teeth serviceable whose alveoli have wasted to the extent of leaving only about one-fifth of the bony socket to support the tooth. In such cases the tooth is retained in its place and prevented from falling out only by the adhesion of the pericementum to some portion of its cementum.

FIG. 658.—In this skiagraph the alveolar processes have been destroyed to an extreme. No bone surrounds the roots of the second molar tooth. The long continued inflammation has caused deposits of cementum about the apices of the roots of the two biscupid teeth. The teeth are held in position only by the adhesions of the pericementum near their apices. Teeth thus deprived of their bony supports have lost their usefulness and should be extracted.

While the suppuration may be arrested in such cases and the gum tissue assume a healthy appearance, the tooth never can be made firm and useful. It is not within the power of human skill to promote regeneration of the dento-alveolar processes. Once they are lost, they are gone forever. To retain such teeth, therefore, in the light of such knowledge, is to disappoint the patient and bring failure to the operator. A single tooth may have had its bony wall destroyed while the walls of those teeth in contact may have been partially destroyed. To retain the one whose socket is lost and attempt to make it useful is an unwarranted procedure. The extraction of such a tooth improves the diseased area and greatly favors the termination of the disease.

The recognition and treatment of the systemic disturbances, which may have to do with the establishment of dento-alveolitis, must be the first consideration, to be supplemented by local treatment.

Local treatment:

1. Correct the occlusion of the teeth, if necessary.
2. By means of a skiagraph, decide as to the extent of the destruction of bone.
3. Adjust retention appliances or splints to the teeth, thus putting them to rest.
4. Remove all deposits from the teeth.
5. Curette surface of denuded cement and bone.
6. Maintain oral cleanliness, without which all local treatment must fail.

A further and very important procedure is to remove the carious borders of the alveolar processes. By reason of the infection, the borders of these processes often become carious. This was, I believe, pointed out first by Dr. Riggs, and the course pursued by him in curetting it away was a great advance in the treatment of this disease. I have no doubt that failure to remove the diseased bone and softened denuded cement about the borders of the dental alveoli often is the explanation of unsuccessful treatment.

Medication.—The medication indicated in the treatment of this disease obviously is to arrest the inflammation before suppuration begins. If suppuration continues after surgical treatment, it is apparent that antiseptics are indicated to destroy the pathogenic micro-organisms which infest the parts and to restore the normal circulation. As stated previously, it will be necessary to maintain thorough oral hygienic methods to secure satisfactory results.

The infected parts may be cleansed either with boric acid or normal salt solution, after which they should be dried as thoroughly as possible with napkins or, preferably, with warm air carried into the pockets, followed by injection of solutions. The value of aromatic sulphuric acid, which is a 13 1/2 per cent. solution of sulphuric acid of commerce combined with the aromatic parts of cinnamon and ginger, has long been recognized as a potent

agent in treating these affections. The first application should be one part of the acid to three of water; the second, one part of acid and one of water, and this may be increased to three parts of the acid to one of water if the conditions require it. Instantly upon its application an improvement in the appearance of the parts will be recognized. It is a matter of regret that proprietary remedies have been thrust upon the members of the profession to so great an extent to the detriment of scientific medication.

Many other agents and combinations have been proposed, among which is the following:

Crystals zinc iodid	2 drams
Distilled water	2 drams
Iodin crystals	6 drams
Glycerin	1 ounce

Thoroughly scale the teeth of all calculus, put on the proper splints and irrigate the pockets thoroughly. The patient should be seen at least twice a week. Any remaining portion of calculus may be located by the area of inflamed tissue which will surround its location.

It is important to instruct the patient to massage the tissues and he should be impressed with the necessity of following instructions carefully, as his co-operation is needed in the successful treatment of the condition.

Conclusion.—The skillful, painstaking and wisely directed work of Dr. W. J. Younger and the successful result of his methods in practice made a deep impression upon the profession and marked an advance step in the treatment of this phase of dento-alveolitis.

The treatment of suppurative dento-alveolitis may be summarized as follows:

1. Observe the manner of occlusion of the teeth. Irregular occlusion is a common cause of inflammation of the dental alveoli. The removal of deposits and the application of medicine cannot effect a cure in the presence of unnatural motion of the teeth.
2. Look for dead and decomposed pulps.
3. Secure a good Röntgen photograph.
4. Extract teeth retained in place only by the attachment of membranes where the bony sockets are lost.
5. Support the teeth and hold them firmly in position by binding them together or otherwise fixing them so that they may be held still and put to rest.

In no place does the old principle of "When a part is in an abnormal state, put it to rest" apply more forcibly than in the treatment of loose teeth. The looseness and constant motion of such teeth in their sockets would defeat the most efficient manipulation in the removal of deposits and medication. It is essential, therefore, that they be "put to rest" in order to effect a cure.

6. The systemic condition of the patient must be understood. It is essential that any diseases from which the patient may be suffering, such as nephritis, rheumatism, gout, tuberculosis, syphilis, etc., should be recognized and treated. It must be understood that local treatment alone, when systemic disease exists, cannot be successful.

Local treatment must be thorough. Suitably formed instruments, capable of reaching the irregular surfaces of the roots, should be employed; all deposits carefully removed; carious borders of the bony alveoli curetted; antiseptic irrigation of the parts made with a suitably formed syringe, the point of which will pass to the very depths of the pockets, and most scrupulous cleanliness of the entire mouth and teeth persisted in. This will be followed by a cure in a very large majority of these cases.

Autogenous Vaccines.—Autogenous vaccines are used now in the treatment of infectious diseases of all kinds. Their use in the treatment of infections of the mouth is yet in the stage of development, with a prospect of effecting a cure in favorable cases.

Emetine.—Emetine hydrochloride has recently been suggested to aid in affecting a cure in dento-alveolitis. It is used as follows: After the teeth have been thoroughly scaled and all points of irritation have been removed, the pus pockets are washed out with normal salt solution. The pockets are then flushed with a weak alcoholic solution of emetine. The patient is instructed to massage the gums thoroughly once a day with the same solution. This treatment is accompanied by hypodermic injection, subcutaneously, of 15 to 30 mg. of emetine hydrochloride. The injection is repeated every third day for six doses. The pus pockets are irrigated every third day but the instrumentation must not be continued after the first formed thorough scaling, for the reason that the granulations within the pockets are broken down, thus rendering the part liable to re-infection.

This treatment is in its infancy and while the results in the hands of a few have been very satisfactory, it is too early to pass judgment on its relative merit.

CHAPTER XXXIII

EXTRACTION OF TEETH

In deciding upon the scope of this book, the author was in doubt as to the advisability of writing a chapter on the extraction of teeth, but as the book is intended for students both of medicine and dentistry, and as medical colleges, with few exceptions, do not teach dental pathology, it seems desirable that abnormalities of the teeth which call for their extraction should be considered here.

Prevalence of Diseased Teeth.—Carefully prepared statistics in the leading countries of the world show that ninety-five per cent. of school children have diseased teeth and that countless maladies originate therefrom. Many of these are treated by physicians who, not knowing dental pathology, wrongly diagnose the cases and fail to cure them. In view of these statistics and others, which show that diseases of the teeth *per se* are more prevalent than any other known disease, medical college faculties ought to engage teachers of dental pathology. Such teachers would be valuable factors in medical education. They would impress upon their students the most approved measures of oral hygiene; the students, after beginning practice, would teach the public and thus prevent, in a great measure, the appalling destruction of human teeth.

Careless Extraction.—With few exceptions, diseases of the teeth can be successfully treated. From time immemorial the laity has applied to physicians and dentists and, for trivial causes, requested the extraction of teeth. Whether pain in these teeth was fancied or real, the physicians or dentists have often complied with their requests without making careful examinations, and extracted teeth but slightly diseased, even sometimes sound and healthy ones. While teeth consist of the hardest tissues in the body, they are often the most neglected, even by those who carefully observe the rules of sanitation, ventilation, etc. Tooth-enamel cannot be reproduced. Once dental caries begins, it continues to complete destruction of the teeth. Nature reproduces skin, bone and muscle, but dental skill alone can treat tooth-enamel and arrest its further destruction.

In Harris' "Principles and Practice of Dentistry," we find the following on ill-advised extractions of teeth:

"There are few operations in surgery that excite stronger feelings of dread, and to which most persons submit with more reluctance, than the extraction of a tooth. Many endure the torture of toothache for weeks rather than undergo the operation. When we take into consideration the frequent acci-

dents occurring in its performance by unskilled individuals, it is no wonder that it is approached with apprehension, but when skillfully performed, the operation is usually effected with ease." Dr. Fitch reports a case serving to illustrate these remarks. The patient, in having the right superior molar extracted by a blacksmith, had a large portion of the jaw and five other teeth removed at the same time. "The roots of his tooth," says Dr. Fitch, "were greatly bifurcated and dovetailed into the jaw and would not pass out perpendicularly, though a slight lateral motion would have moved them instantly. The jaw proved too weak to support the monstrous pull; it gave way between the first and second molars and with it came both the anterior and posterior plates of the antrum. The broken portion extended to the spongy bones of the nose and terminated at the lower edge of the socket of the left front incisor. It contained six sound teeth: the first molar, the bicuspids, cuspid and incisors on the right side. The soft parts were cut away with a knife. A severe hemorrhage ensued and when the patient recovered, his face and mouth were excessively deformed."

About 300 B.C. Erasistratus, the famous scientist who first dissected the human cadaver, deposited in the temple of the Delphian Apollo a "leaden odontogogue," which he would call a tooth-drawer (forceps), to prove that only those teeth should be removed which are relaxed and for which a leaden instrument would suffice. This statement, while extreme, should make an impression on our generation. Extracting teeth for the slightest causes betrays ignorance of their importance, for while a leaden instrument is sufficient for extracting teeth which cannot be retained, many extractions are required which only the best steel instruments can effect.

Experiences in times of war furnish examples of the Government's failure to provide adequate dental care for the soldiers. Formerly it was the hospital steward's duty to extract the teeth of officers and men, teeth which might often have been preserved if treated by competent hands. Today nearly all nations employ skilled army dentists.

Loss of Teeth Irreparable.—*The loss of human teeth is irreparable.* Dental skill has won just praise for its remarkable accuracy in imitating natural teeth and adjusting artificial dentures, but the highest skill cannot fully equal the marvelous work of nature. The way people of all nations sacrifice their teeth without rational cause is a sad comment on human intelligence. Professional men cannot be excused from failure of duty if they let themselves be influenced to extract teeth which may be restored to health and usefulness if carefully treated.

A physician's first duty is to make a diagnosis. To say a patient has odontalgia or toothache and then ask what treatment should be employed, would be like saying a patient had a headache and then asking how to treat it. The only rational answer to such questions would be, to quote Professor J. Adams Allen, the late president of Rush Medical College, "It depends on what's the matter." Odontalgia may depend upon one of many causes.

It may be pain reflected from a part immediate or remote (see page 934). To extract teeth without knowing whether they are normal or diseased, whether the pain exists in the teeth or whether it is reflected from other parts, is like amputating a limb without knowing why. By these statements we are led to ask the question: *Why should teeth be extracted?*

Education of the Laity.—Unfortunately, not knowing prophylactic measures, parents often neglect their children's teeth, so the teeth become carious, exposure of their pulps occurs and pain ensues. To obtain relief, parents often have the teeth extracted, a procedure not warranted unless

Fig. 659.—Forsythe Dental Institute, Boston.

advised by a competent dentist. Philanthropists of today are giving generously for the inspection and care of poor children's teeth and for the general education on oral hygiene. Through the generosity of the Forsyth Brothers of Boston, a large, well equipped building has been erected (Fig. 659) which, together with the endowment funds, represents an expenditure of two million dollars to be used for such education and for treating the teeth of children unable to compensate a dentist for his services.[1]

The Chicago Department of Health has demonstrated the great danger of infection being transmitted by decayed teeth. Many cases of measles, scarlet fever, diphtheria and other diseases have been traced definitely to infectious material carried in the mouths, especially in the teeth of children, the same being found in the cavities of the decayed teeth several weeks after the children had been permitted to return to school. Under the aus-

[1]As we go to press, we learn that Mr. Eastman, of Rochester, has liberally endowed a similar institute.

pices of the Chicago Dental Society examinations are being made and free dental dispensaries have been established. The dispensary operations have been performed by volunteers from the dental profession.

The first systematic work done for the care of poor children's teeth was conducted by Professor Ernst Jessen of Strasburg, Germany. The successful work of the International Hygiene Commission, of which he is the president, has influenced all nations so that today nearly all countries are engaged in organized effort to prevent the decay of children's teeth and preserve diseased ones. We may, therefore, assume that in the future the condition of human teeth will be greatly improved. We may expect that the indiscriminate extraction of children's teeth will be practised no longer.

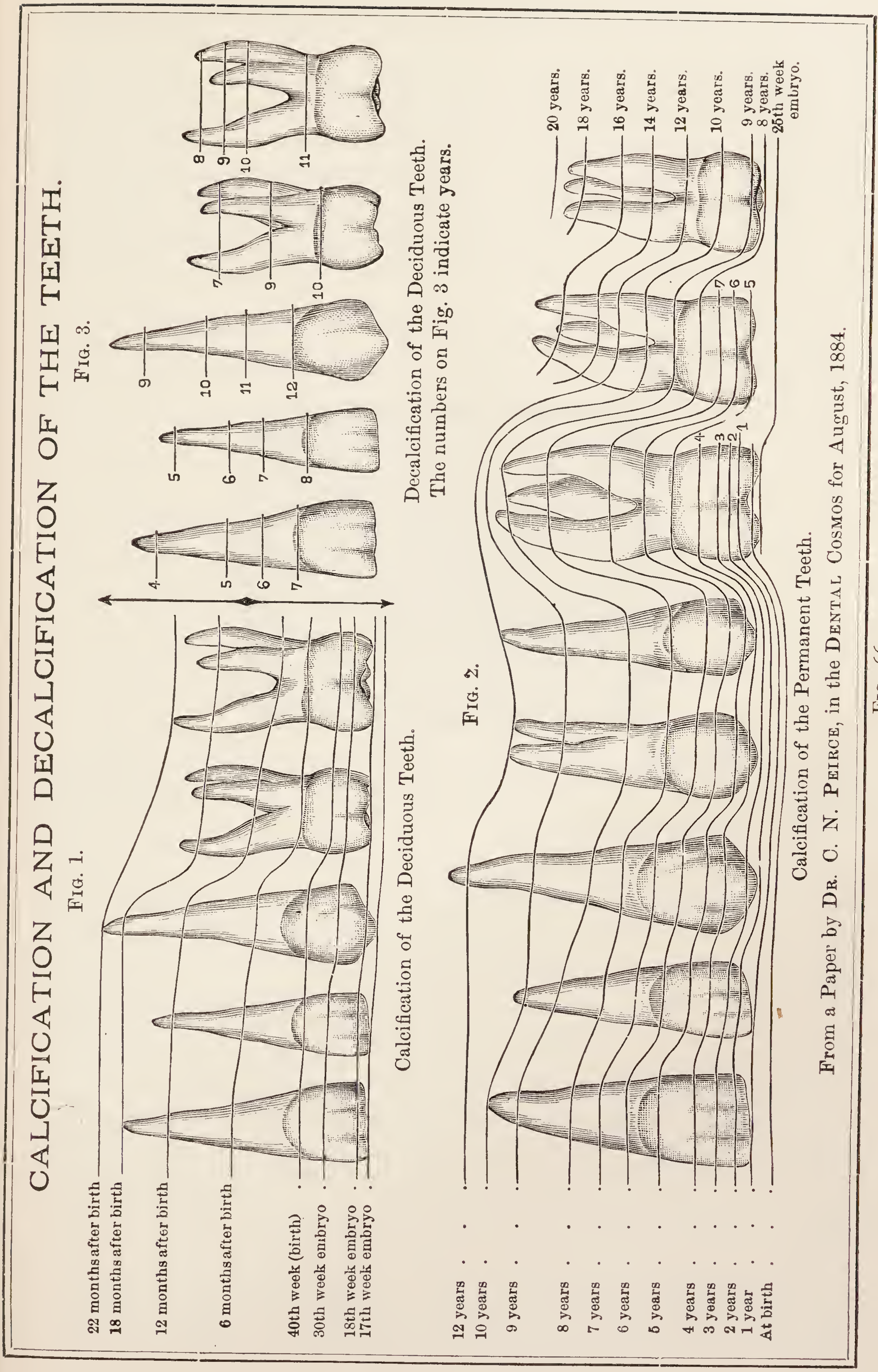
Preservation of Deciduous Teeth.—A deciduous or temporary tooth, even though decayed so far as to expose its pulp and become painful, should not be extracted, but carefully treated and preserved. Far better would it be if the decay of temporary teeth were arrested and exposure of pulps prevented by careful dental services. Many parents are ignorant of the value of these temporary teeth, arguing that they may as well be extracted at once as they will be replaced by permanent ones. Temporary teeth have a useful function to perform and should be retained until the permanent ones take their place.

Deciduous Teeth should be Retained.—Deciduous teeth should be retained their full term for the known beneficial influence their presence has upon the normal development of the jaw bones and face. Many deciduous teeth are extracted before their functions are performed. The deciduous molars should be retained until the eighth or ninth year. By that time the first molars are well developed and it is possible to maintain correct occlusion with these until the bicuspids succeed the deciduous molars. It is essential also that the deciduous cuspids should not be extracted until it is time for their successors to erupt, as the space they occupy is almost invariably lost by the moving together of the bicuspids and lateral incisors and the permanent cuspids are crowded out of the arch. If the vitality of the first permanent molar is lost before the tenth or eleventh year, it will usually be exfoliated, and if such be the case, it is best extracted immediately so that the second molar may usurp its place in as great a degree as possible and prevent malocclusion.

CALCIFICATION AND DECALCIFICATION OF THE TEETH

In an excellent article entitled "Calcification and Decalcification of the Teeth,"[1] Dr. C. N. Peirce treats of the absorption or decalcification of the roots of deciduous teeth (Fig. 660). Dr. Pierce regarded this process as both physiological and somewhat obscure. He wrote: "The evidence that it results from a physiological action is the fact that no matter how far absorp-

[1] Dental Cosmos, August, 1884.



CALCIFICATION AND DECALCIFICATION OF THE TEETH.

From a Paper by Dr. C. N. Peirce, in the Dental Cosmos for August, 1884.

Fig. 660.

tion has progressed, the moment vitality of the pulp ceases, this retrograde metamorphosis terminates.

It is difficult to state the exact cause of this molecular dissolution, though the several conditions which are always present are readily recognized, but the part they play is too obscure to be easily ascertained. The manner of its commencement, when successful—always at the end of the root (Fig. 661)—and the presence of a vascular papilla in close proximity to the absorbing surface are, with the retention of pulp vitality, its three essential accompaniments, and the absence of any one of them would militate against the completion of the process.

The statement that the presence and pressure of the permanent tooth are essential cannot be sustained, for frequently the decalcification of the decidu-

Fig. 661.—*X*-ray illustrating the eruption of the permanent teeth with absorption of the roots of the deciduous teeth. The skiagraph shows a space between the enamel of the cuspid and the partially absorbed root of the deciduous cuspid. The space is filled with the intervening vascular papilla.

ous tooth is successfully accomplished in the absence of its successor; and, again, we often find the permanent tooth impacted against or within the bifurcated roots of the deciduous molar or pressing down by the side of its single-rooted predecessor, both being more or less displaced by the persistence of the deciduous tooth without absorption. That the organ has performed its function and that the nourishment which it has previously appropriated is diverted or relegated to its successor is probably the most plausible explanation we can give of this interesting physiological process."

By studying Fig. 660, and carefully noting the developmental steps of the deciduous teeth, the student will become familar with the process of calcification; then, turning to Fig. 3 he will note the process of decalcification and become acquainted with the dates when the roots of these teeth have sufficiently decalcified to call for their removal.

When the process of decalcification of the deciduous teeth progresses harmoniously with the eruption of the permanent teeth, the crowns exfoliate without assistance. If, however, the decalcification is irregular, the crown

may remain firmly in place while the permanent tooth works its way outward and may be diverted from its proper course by the temporary tooth. Often we see a permanent tooth erupted, diverted lingually or labially by the temporary tooth, the place of which it should take. Such a condition clearly indicates that the temporary tooth has been retained too long. Sometimes we see a child whose teeth suggest nothing so much as a bramble of bushes, where both deciduous and permanent teeth are in the greatest confusion, a condition which causes malocclusion of the permanent set.

The order of eruption of the deciduous teeth is as follows:

Central incisors	5 to 8 months
Lateral incisors	7 to 10 months
First molar	12 to 16 months
Cuspids	14 to 20 months
Second molar	20 to 36 months

The eruption of permanent teeth takes place as follows:

First molars	6 to 7 years
Central incisors	5 to 7 years
Lateral incisors	7 to 9 years
First bicuspids	9 to 10 years
Second biscuspids	10 to 12 years
Cuspids	11 to 13 years
Second molars	12 to 14 years
Third molars	17 to 21 years

Contra-indications to Extraction.—Diseases of the teeth sometimes compel patients to seek relief, and, not knowing the possibilities of tooth conservation, such patients follow the course pursued by their ancestors, demanding the extraction of certain teeth which they believe to be the seat of pain. Right or wrong in their conclusions as to the cause of pain, they do not realize the extent of the loss following the extraction of their teeth. It becomes the duty of the operator, therefore, not only to examine the condition of the teeth themselves, but also to ascertain whether any systemic condition contra-indicates extraction. The question is, whether or not a tooth is diseased beyond preservation; if so, its extraction is indicated.

Next, the patient's condition should be considered. There are certain idiosyncrasies which should cause an operator to pause before extracting any tooth. He should avoid, as far as possible, the extraction of teeth for those suffering from neurasthenia or from epilepsy, those with a hemorrhagic diathesis and women during the periods of menstruation, gestation and lactation. Abundant evidence is on record where thoughtless extraction of teeth for women has produced shock, caused systemic disturbances and led to premature child-birth.

Dr. Thomas C. Stellwagen, in the American System of Dentistry, states: "Premature labors, congenital deformities and monstrosities have been

charged to the same cause. Mental agitation in the case of a nursing mother has been followed by the immediate death of her child after suckling,[1] supposed to have been due to her mammary glands having their secretions altered by some occult reflex nervous action so as to become actually poisonous. The case referred to was one where the infant is distinctly stated to have been in good health prior to the motherly attention which, designed for its nourishment, apparently proved the cause of its sudden death. From this it may be inferred that, under all circumstances, the husband, mother or friend of the pregnant or nursing woman should be cautioned against permitting any but the most urgent surgical operations, or, indeed, anything even remotely calculated to work mischief by agitating the mother or disturbing the nerve-force or blood-flow. Finally, should such a misfortune have happened, the mammary glands should be artificially emptied once or twice by the mouth of an attendant, or, if that is not possible, then some other means, as a breast-pump, should be employed. Neglect of this simple precaution has doubtlessly often been followed in the nursling by malaise, sickness or even serious illness, the cause of which may not have been carefully or correctly diagnosed. In such momentous affairs, caution and care cannot be too thoroughly enjoined as a matter both of principle and policy. By ignoring any or all of these guards for the health of the person under charge, conditions may be induced which may cause those most interested to suspect the operator of being negligent or inattentive to the very momentous duty of shielding his patients from injury, direct or indirect, and, in those most favorably disposed, at least, would be a not unjust cause of unpleasant feeling or even of pronounced condemnation. On the other hand, such thoughtful heed on the part of the dentist will, by its own merit, entitle him to the confidence of his more intelligent patients and effectually secure for him their affectionate regard.

It may be stated that many grave complications have occurred after far simpler operations. Sir James Paget reports an instance where such a trifling procedure as the removal of a small cyst was followed by erysipelatous inflammation and death.[2] The slightest wound, yea, the prick of a pin, has been followed by most disastrous consequences.[3] How much greater must be the dangers that surround the extraction of even a single tooth can be inferred from a glance at the parts and a knowledge of their intimate relations with the nervous and circulatory systems. The existence of such multiform connections makes it a very grave question as to the propriety of performing the operation in cases where these related tissues are already threatened or subject to some abnormal condition, as hysteria or hemorrhagic diathesis. This is so true that those who are conscientious and understand the gravity of the expressions divide the responsibility by consultation with a fellow-practitioner before operating" (Figs. 662 to 664).

[1] See Carpenter's Physiology, 1862, p. 742.
[2] Paget's Clinical Lectures and Essays, page 65.
[3] Holmes' System of Surgery; Eve's Collection of Remarkable Cases in Surgery.

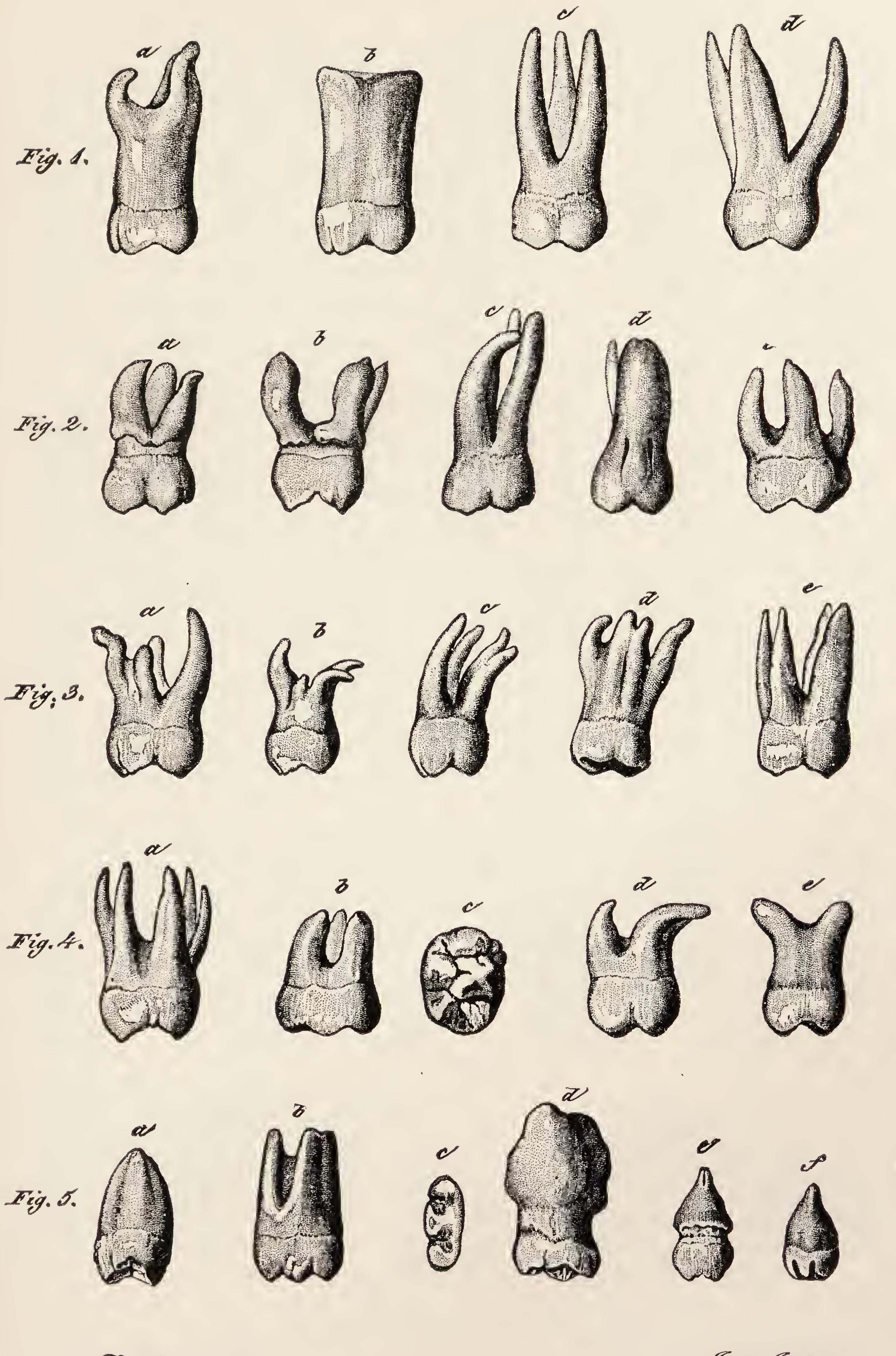


Fig. 662.—Specimens of abnormally shaped teeth including fused, exostosed and multi-rooted. (*Am. System of Dentistry.*)

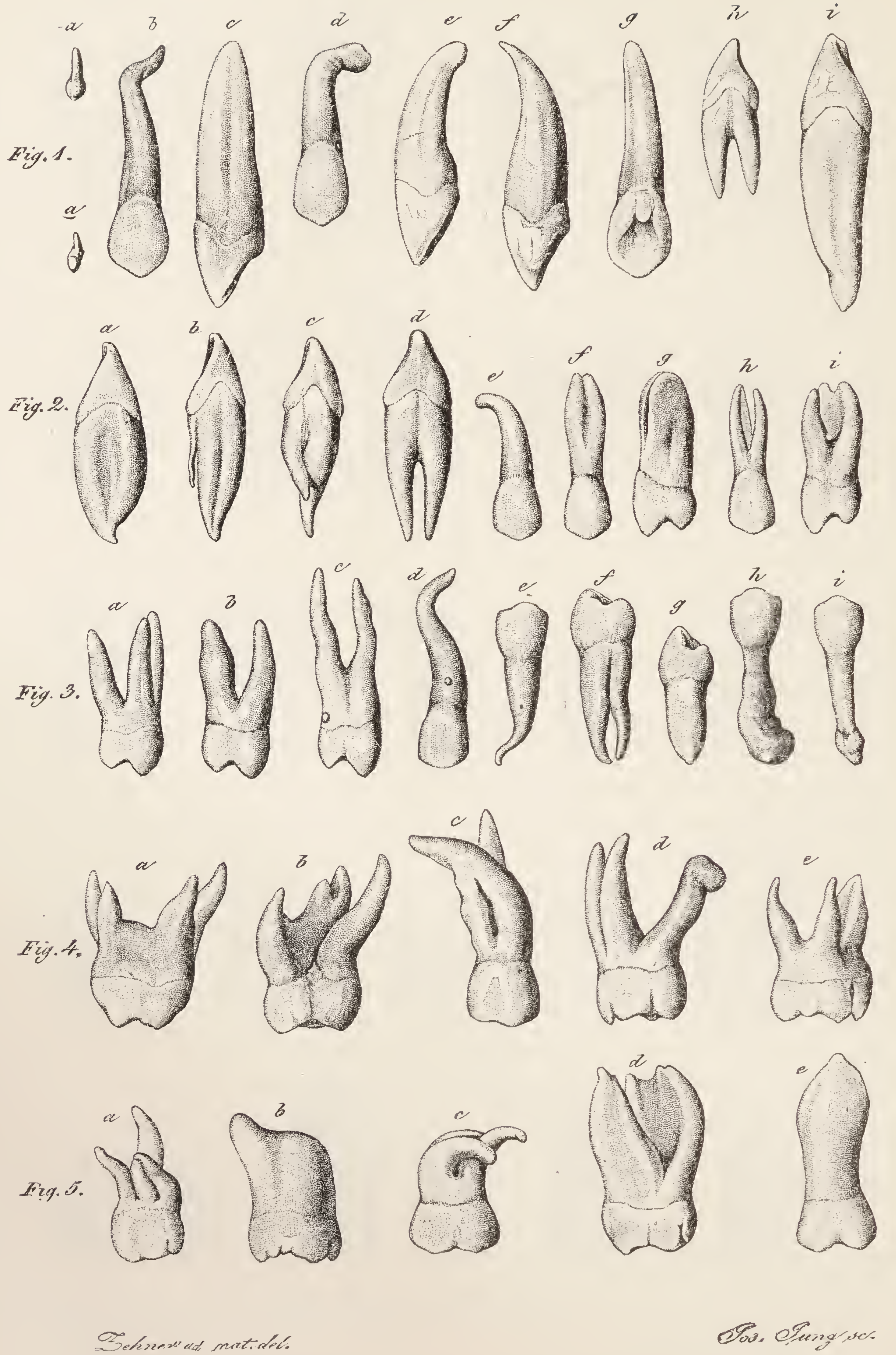


FIG. 663.—Specimens of abnormally shaped teeth, showing exostosed, bifurcated and twisted roots. (*Am. System of Dentistry.*)

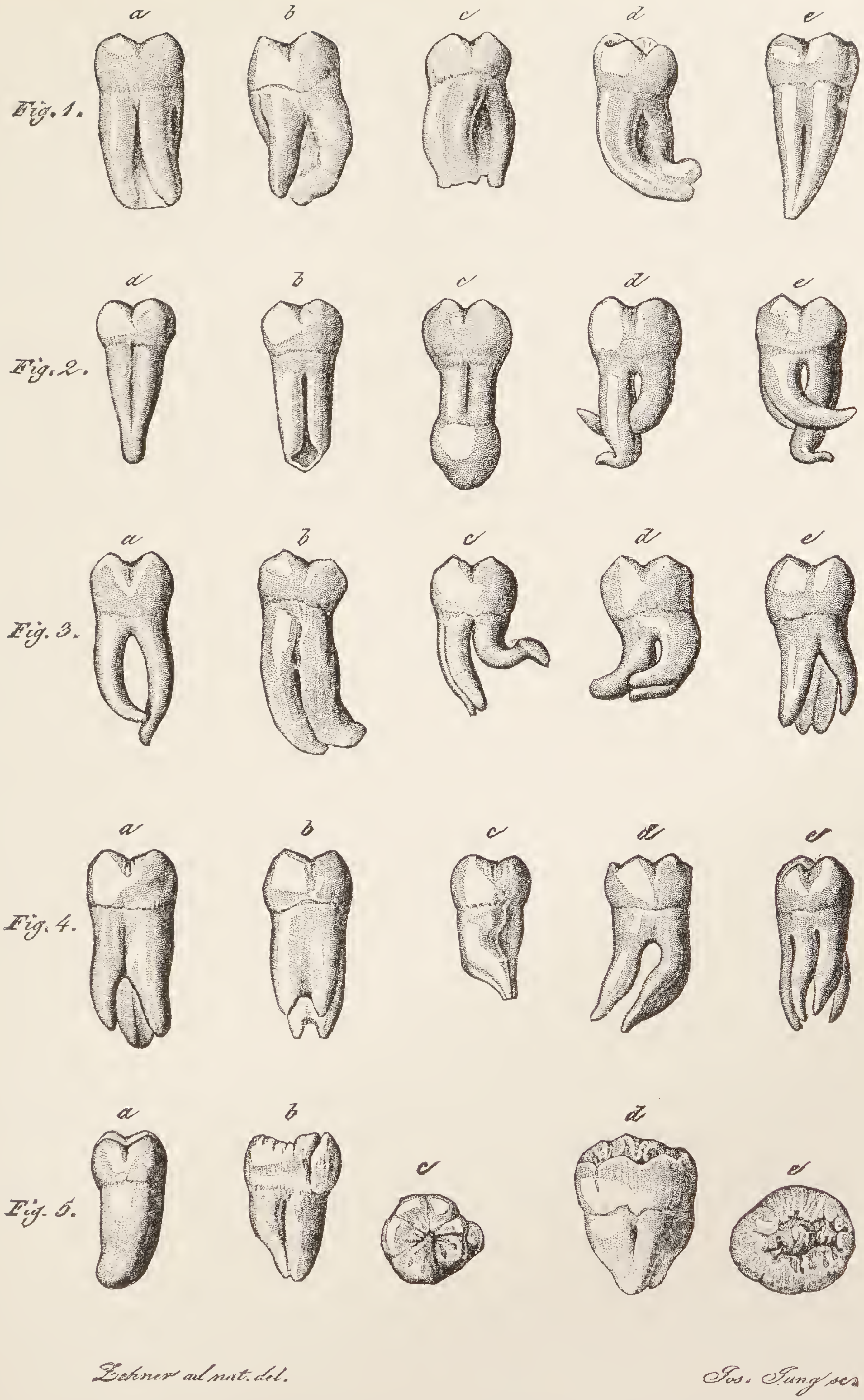


Fig. 664.—Specimens of abnormally shaped teeth showing fused, exostosed and hooked roots. (*Am. System of Dentistry.*)

SUMMARY OF THE INDICATIONS FOR EXTRACTION

Deciduous Teeth.—1. Deciduous teeth, the roots of which are absorbed by the incoming permanent teeth.

2. Teeth which are retained too long and are obstructions to the incoming permanent teeth, often diverting them from their normal position, in which case the incoming crown of the permanent tooth is directed either inward or outward, the deciduous and permanent teeth occupying positions side by side. It often occurs that certain roots of the temporary teeth are absorbed while others are not changed and are, therefore, firmly retained in place.

3. Teeth about which infection has taken place, endangering the vitality of the bone and the general health of the patient. In such cases the operator must exercise judgment. Curable abscesses should be treated, while infection and destruction of the bone surrounding the roots necessitate extraction of the teeth. Precaution should be observed, however, such as having the pus evacuated and the parts made as clean as possible before the teeth are extracted.

4. Deciduous cuspid teeth should never be extracted to make room for crowded incisors. The greatest error, perhaps, made in extracting deciduous teeth is the removal of the cuspid to make room for the crowded lateral incisor. It will be remembered that the incisors and bicuspids erupt and take their place while the temporary cuspids remain.

Removing the temporary cuspid to make way for the incoming lateral incisor, which may be crowded somewhat and slightly diverted from its proper place, will lead to a further unfortunate complication, since the lateral incisor will move backward and the bicuspid forward until they come in contact. The incoming permanent cuspid, therefore, when moving downward, finding its place filled by the lateral incisor and first bicuspid, will move anteriorly or posteriorly and there it will remain far out of its position. This leads to an irregularity and loss of facial contour, calling for expert orthodontial methods for its correction.

Permanent Teeth.—The extraction of permanent teeth is generally to be regretted. Certain conditions, however, necessitate their removal, such as:

1. Pulpless teeth, or roots of teeth which have become loose and constantly irritate the surrounding parts.

2. Teeth that have been split so that they cannot be restored by banding the roots.

3. Supernumerary teeth.

4. Teeth, the roots of which are involved by excementosis. Certain of these cases, however, can be remedied by amputating the enlarged part of the root.

5. Teeth, abscesses from which involve the antrum (see antrum) frequently have been extracted in order to secure drainage. However, modern methods of opening the antrum through the canine fossa and thus establish-

ing drainage make the removal of such teeth unnecessary, as they may be successfully treated by opening into the crowns, cleansing the pulp canals antiseptically and filling them, thus preventing a recurrence of infection.

6. Teeth, the alveolar processes of which have been entirely destroyed by suppurative alveolitis (so-called pyorrhea alveolaris), should be removed. Such teeth, having been deprived of their bony support, cannot remain useful by adhesion of soft tissue only. They are detrimental to the patient's well-being since they are valueless in masticating and are centers of constant general infection.

7. Teeth that are impacted and irritate the surrounding soft parts often are the initial lesions of trifacial neuralgia and sometimes the nuclei of cysts and tumors.

8. Formerly teeth were removed for the correction of overcrowded arches and irreparable injuries followed such extractions. Modern methods in orthodontia have made such extractions, with rare exceptions, unnecessary. The most careful consideration by expert orthodontists should be given teeth in crowded arches before extracting.

9. The first permanent molar, if the vitality of its pulp is lost prior to the eighth year, if troublesome should be removed. Following the death of the pulp, there is arrested development of the root. In such cases the tooth is not of permanent value.

Preparation of Patient.—If there is a well-developed abscess and the contents of the sac can first be evacuated by lancing or aspirating, that should be done, for in such cases there is danger of general infection.

From the outset antiseptic precautions should be rigidly observed. The patient should rinse the mouth thoroughly with a saline or boric acid solution, thus clearing away the mucus, any portions of food remaining and the secretions that are so abundant in a mouth subject to irritation, thus reducing the danger of infection to a minimum.

The teeth should be carefully examined with a fine exploring instrument and mouth mirror. The position of each tooth to be removed should be carefully noted as, when the mouth is filled with blood and saliva, examination is difficult, especially if the operation is to be done under a general anesthetic.

Position of Operator and Patient for the Extraction of Teeth.—Have the patient seated in a solid chair, his head tipped slightly back on a level with the chest of the operator, who takes his position on the right side and passes the left arm around the patient's head. The operator's fingers are placed between the lips in such a way as best to expose the teeth to be extracted and protect those not to be removed. This position is maintained when removing all superior and inferior teeth from right lateral to left third molar, with but slight shifting of palm and fingers to best support the face or mandible and protect the lips from injury. Some operators find it convenient to lower the patient and have his head carried slightly forward when extracting the inferior teeth. When removing all superior and inferior teeth from right cuspid to

third molar, the operator takes a position to the right of and facing the patient. The lips should be protected and the face and body of the mandible sustained with the palm and fingers of the left hand.

Extraction of Children's Teeth.—The extraction of children's teeth requires great tact. Frequently, having the child's confidence, the dentist will lose it by promising to cause no pain. To make such a statement to a confiding little one and then cause pain, which the dentist knows to be inevitable, is inexcusable. Frequently a ring, made from a small rubber tube, slipped over a deciduous tooth and worked down a little beneath the gum, will, in a few days, suffice to separate the gum tissue from the neck of the tooth; this may be done without causing much pain. Then, if the roots are well absorbed, the tooth will drop out or may be removed with the finger. The removal of deciduous teeth, which are still firm in their sockets, sometimes becomes necessary, but this is difficult since their roots diverge more than the roots of the permanent ones. In proportion to their size, these roots have a firmer hold upon the alveolar processes than the roots of the permanent teeth. The use of an anesthetic is, therefore, imperative.

It is assumed that the anatomy of the teeth has been studied and that the operator can differentiate between temporary and permanent teeth. On the enamel, just at the gum border, a temporary tooth has a decided bulge which is not present on a permanent tooth, and this bulge or heavy ridge should be recognized as a diagnostic sign when other means of making the distinction fail. Sometimes it happens that a central temporary incisor and a central permanent incisor are present at the same time and both teeth firm in their sockets. In such a case it is necessary to recognize and remove the temporary tooth, not the permanent one.

Great care should be exercised when extracting deciduous teeth that the beaks of the forceps are not carried to a depth that might engage the oncoming permanent teeth. Take the same position outlined as appropriate for the extraction of permanent teeth.

In the extraction of roots of teeth that have broken off on a line with, or below, the alveolar border, the bone should be exposed so that the forceps may be carried down and over it in such a way as to embrace not only the root of the tooth, but a little of the alveolar process of both the interior and exterior alveolar plates; then with alveolar forceps a little of the bone, together with the roots of the tooth, may be taken away.

In operating for the removal of such a root, the lancet may be employed advantageously, not in encircling the root to separate the gum from it, but an incision should be made through the gum, parallel to the root, so that when the forceps are placed over the border of the bone they will not lacerate the gum, but leave a clean cut through the gum-tissue. After the removal of the root, the gum will heal promptly without disfigurement. The motions to be employed and the force to be exerted in the removal of a tooth or root depend upon its form and location.

INSTRUMENTS

Before the middle of the nineteenth century, the key of Garrengeot was extensively used for extracting. This was an important instrument in its time and for centuries the only one relied upon. About three portable hooks, varying in size, were supplied for each key. The leverage applied by the key was often followed by fracture of the external alveolar border, when tooth, bone and all were carried away. This key, of course, is no longer in use. About six well-selected tooth forceps, with two elevators, will suffice for ninety per cent. of all cases. Occasionally a forceps of special design is needed. For removing temporary teeth, forceps have been designed of smaller size and more delicately made than those used for removing permanent ones. While these are desirable, forceps for permanent teeth are successfully used for both kinds of teeth.

Lancets are sometimes employed to separate the gum-tissue from the neck of the tooth. These are seldom used today since the beaks of the forceps are made to serve the same purpose.

Forceps for Extraction of Permanent Teeth.—

1. Upper and lower incisors, cuspids, bicuspids, and all roots can be removed by Dr. M. H. Cryer's Universal Forceps, Nos. 150 and 151, S. S. White & Company.
2. For superior first and second molars, employ S. S. White & Company's No. 24, either side.
3. For inferior first, second and third molars, use S. S. White's forceps No. 17.
4. For superior third molars, S. S. White's No. 32 bayonet-shaped forceps, designed by Dr. Parmly.
5. For lower molar roots, especially those broken off below the border of the alveolar process, No. 52, alveolar, full-curved forceps, designed by Dr. Parmly, may be used.

The elevators (Fig. 671) designed by the author have given most satisfactory results. The force is applied by rotating. The blade being small, it can be inserted in a small space. They are especially valuable in removing impacted lower molars where the force must be applied very gradually in order to avoid the possibility of a fracture of the mandible. Elevators are of many forms, but those illustrated will answer almost every purpose. This instrument should be used for the purpose of *elevating*, not as a lever to crowd a tooth backward. If properly used, it will elevate or lift a tooth from its socket, often with much less injury to the surrounding parts than would result from the use of forceps. This instrument should be well guarded so that it cannot puncture the surrounding parts.

A tooth adjoining the one to be removed is used as a fulcrum, and when the elevator has been carried between the teeth, the handle is rotated and the sharp blade of the elevator imbeds itself slightly into the diseased tooth or

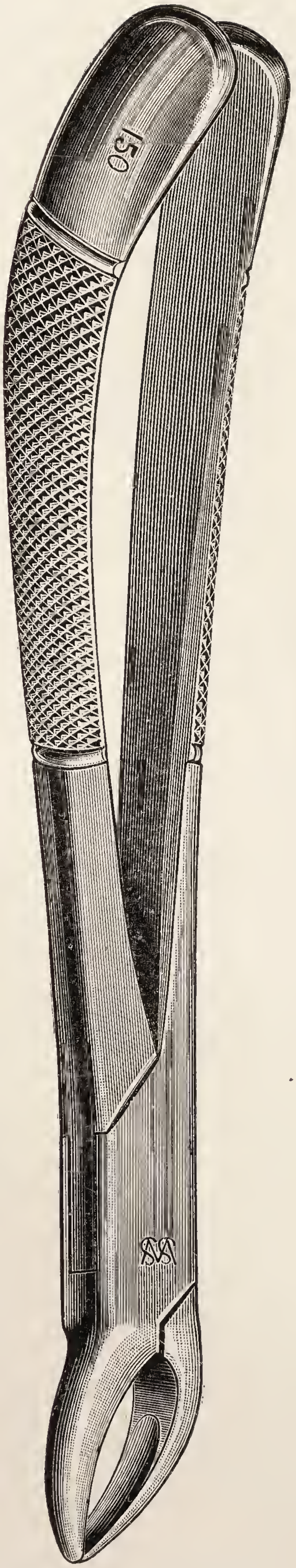


Fig. 665.—Dr. Cryer's Universal forceps.

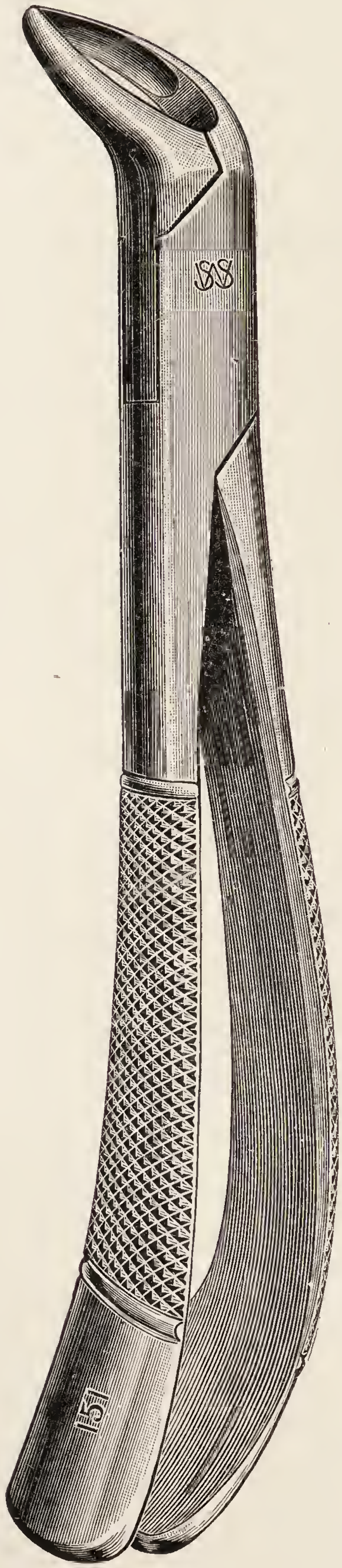


Fig. 666.—Dr. Cryer's Universal forceps.

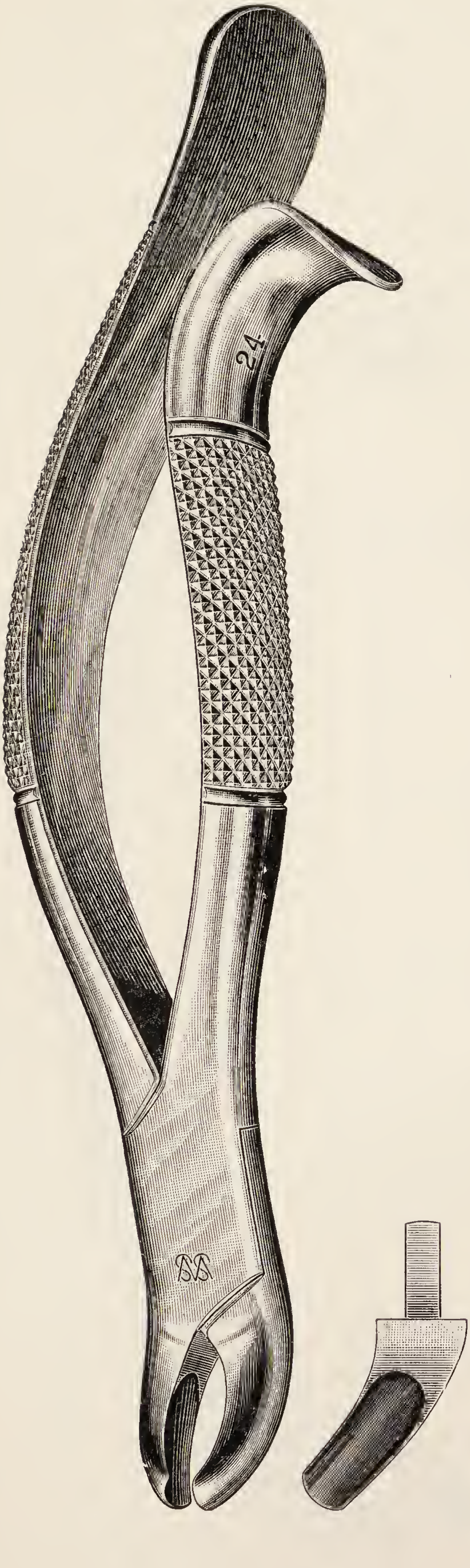


FIG. 667.—Extraction forceps used on the first and second molars.

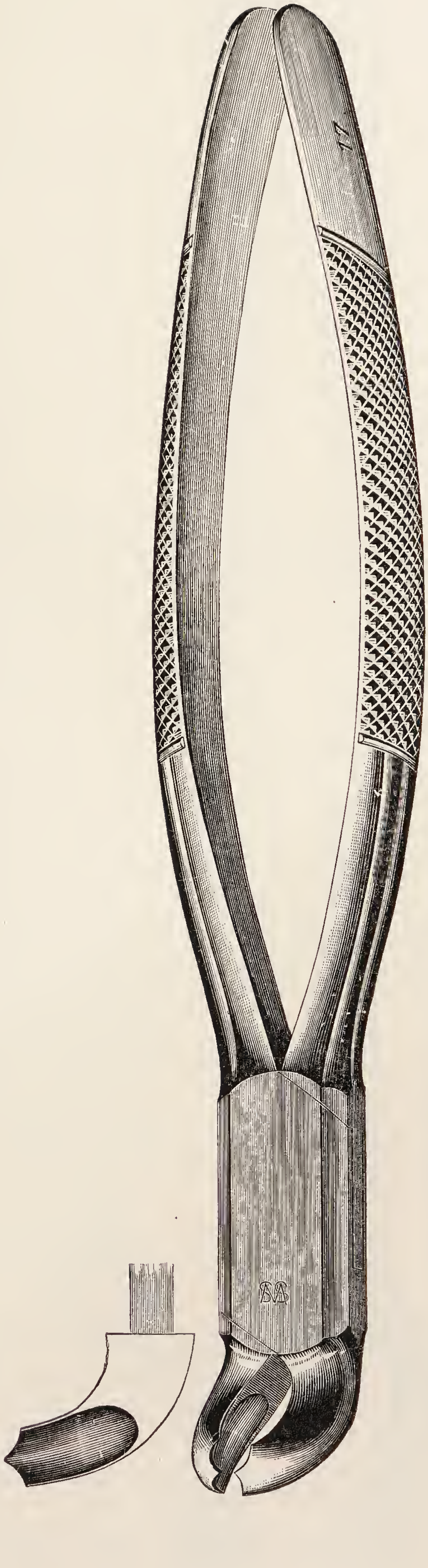


FIG. 668.—Extraction forceps used on the inferior, first, second and third molars.

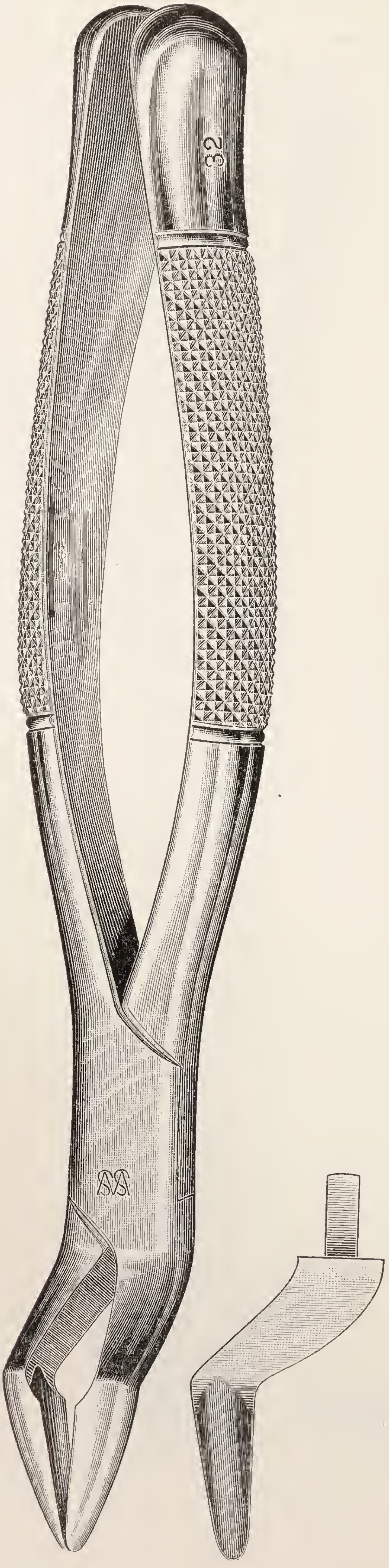


FIG. 669.—Dr. Parmly's Extraction forceps.

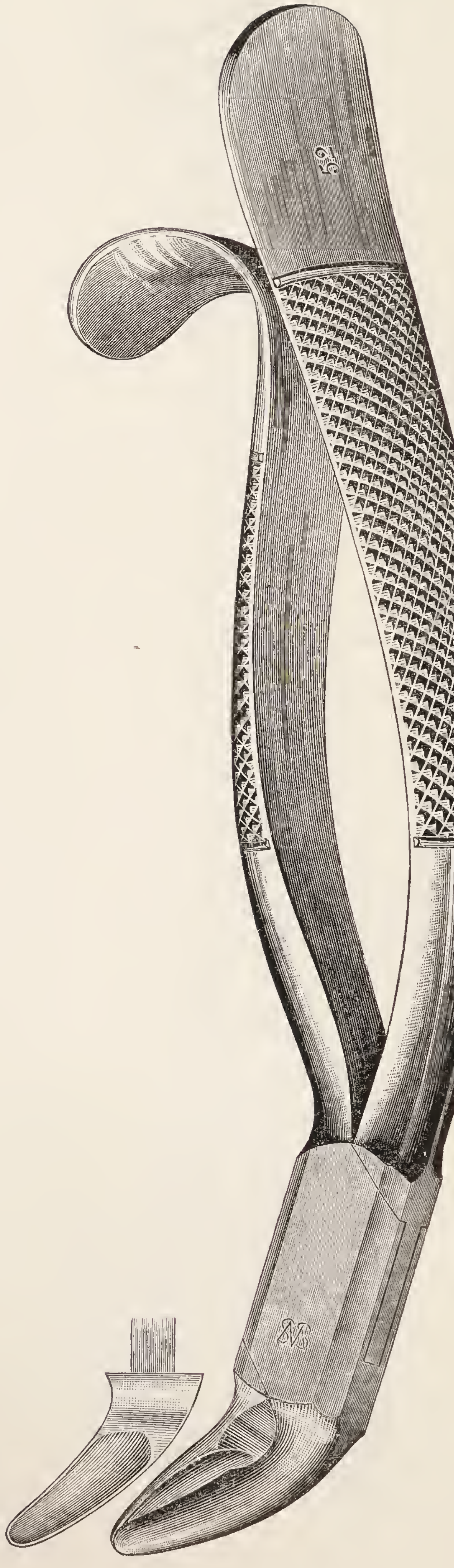


FIG. 670.—Dr. Parmly's full curved forceps.

root, enabling the operator to lift it from its socket. Care must be exercised to avoid leverage backward for such improper use of the elevator might cause fracture of the mandible.

OPERATION OF EXTRACTION

The operation decided upon, the patient must be prepared and properly posed in the chair. If an anesthetic is to be employed, all the facilities necessary to care for the patient should be at hand to meet any emergency. (See Anesthesia.) A suitable mouth-prop should be used so as to keep the patient's mouth open during the operation. The absence of this precaution greatly embarrasses the operator in his work, as the patient may close the mouth spasmodically and thus prevent access to the teeth.

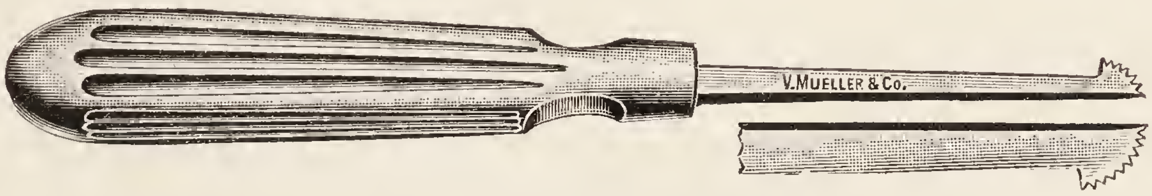


FIG. 671.—Author's elevators for extracting teeth.

Forces Employed in Extraction of Permanent Teeth.—

Superior Incisors

First employ a light rotary motion and then carry the tooth bodily in an inferior labial direction with slight traction.

Superior Cuspids

Carry the tooth in a labio-lingual direction with positive, careful traction.

Superior First Bicuspids

Apply force cautiously in a bucco-lingual direction; positively no rotary motion should be employed for fear of fracture of the frail root-ends.

Superior Second Bicuspids

Apply a slight buccal and rotary motion, with gradual traction.

Superior First and Second Molars

Employ positive downward and slight buccal movement until the lingual root is gradually loosened, then careful bucco-lingual traction, without rotation.

Superior Third Molars

These are extracted by the creation of buccal traction.

Inferior Incisors

These are removed by the application of labio-lingual motion. There is great danger of root fracture with application of the slightest rotary force.

Inferior Cuspids

Use first a labio-lingual force, then a gradual rotary traction.

Inferior First and Second Bicuspids

Apply a bucco-lingual force, then slight rotary motion.

Inferior First and Second Molars

Employ a bucco-lingual and traction force, without any rotary motion.

Inferior Third Molars

This is the most difficult tooth to extract. The direction of the force to be applied should be slightly inward, with positive traction directed a little backward. To grasp partially erupted inferior third molars, the alveolar process and soft tissues on the buccal and lingual sides must be cut away before the beaks of the forceps can be properly placed.

For impacted lower third molars, see page 805.

ACCIDENTS

The extraction of teeth is of such common occurrence that the laity, as well as dentists and physicians, are apt to consider it a simple operation. This is unfortunate since, first, the laity has not been taught the value of teeth and the great loss sustained by their removal, and, second, professional men, instead of approaching a simple operation, may meet most serious complications. It is well, therefore, to keep fully informed as to the complications and accidents which may arise, how to prevent them and, if occurring, how to meet them.

Opening Antrum.—Efforts to remove roots of upper bicuspid and molar teeth have been followed by crowding them into the antrum. In the removal of molar roots, a buccal root might pass into the antrum without the knowledge of the operator. It is easily understood how this could occur, especially where the roots of several teeth are being removed. Once in the antrum, the root becomes a source of irritation and, oftentimes, infection, thus establishing empyema of the cavity. Successful treatment of such a condition requires the removal of the root and thorough irrigation of the cavity. (See Fig. 228.)

Fractures.—In the extraction of the third superior molar, the elevator should not be employed, as there is danger of fracturing the tuberosity of the bone. In the hands of the most successful operators, such fractures occur even when forceps are used. Moreover, occasionally we find the crown of the third molar of conical shape, which makes it rather difficult to fix the forceps upon it. There are cases on record in which this tooth, by reason of its shape, has slipped from the forceps and passed directly into the antrum. Such accidents have happened to operators of high repute. They are often unavoidable.

Fracture of sound teeth adjoining the tooth or root to be extracted may occur from the use of too large forceps. A tooth is sometimes more easily removed than the operator anticipates and, if the force exerted is greater than required, when the tooth is separated from its socket the forceps may strike a tooth in the opposite jaw with such violence as to fracture it. To guard against such accidents, the fingers of the left hand should always protect the other teeth.

Fracture of the alveolar process, usually carrying away a portion of the external alveolar plate, is of more frequent occurrence than other accidents attending extraction. If only a small piece of the bony plate is fractured from its surroundings, it should be removed. If, however, a considerable portion of the alveolar process is separated from the body of the bone, it is better to crowd it into place and allow it to remain.

One of the most serious accidents that may occur is fracture of the mandible. This may result from a weakened condition of bone, due to caries or necrosis; to its partial destruction by the presence of a cyst; it may be weakened by tuberculous or syphilitic degeneration, actinomycosis, the action of phosphorus, or by the previous extraction of one or more teeth and the consequent absorption. If the bone is partially destroyed by the advance of disease, its fracture may occur with little force. If, however, the bone is healthy, it should not fracture if care is used. (See Chapter on Fractures.)

A complication following extraction, which is not uncommon, is extreme hemorrhage. (See Chapter on Hemorrhage.)

IMPACTED TEETH

Nature has provided for two dentures. The teeth of the first, or temporary denture, are erupted between the sixth and twenty-fourth month; those of the second, or permanent denture, between the sixth and twenty-fifth year. Usually, however, the permanent denture is complete by the twentieth year.

Impaction of deciduous teeth rarely occurs. Failure of eruption of teeth, generally considered and spoken of as impaction, is limited to supernumerary teeth and to any of the permanent teeth. An impacted tooth may be the center of marked physical disturbance. By exerting pressure upon the surrounding nerves, it may be the cause of most extreme neuralgic pains, the origin of which has often been obscure to the diagnostician. Any impacted tooth may lie in contact with an important nerve branch and become a source of irritation to the surrounding nerves, thus acting as an exciting cause of trifacial neuralgia (Figs. 672 and 673).

Prior to the advent of the Röntgen photograph, extraction of the entire denture was often resorted to in the treatment of patients suffering from neuralgia, the cause of which was impacted teeth. Now, happily, this valuable adjunct may be resorted to and should be in every obscure case.

Impacted Supernumerary Teeth.—The reason for the impaction of a supernumerary tooth is that no place has been provided by Nature for its reception. It drifts, therefore, from its place of development deep in the submucous tissues and, while it may make its appearance either anterior or posterior to the alignment of normal teeth, it may come in contact with tooth roots, there remain and become permanently impacted in the bone. A supernumerary tooth may cause impaction of a normal tooth. Two cases of this kind have been reported by Professor Kirk. He says in his collection:

"There were thirteen small supernumerary teeth developed in the position of the root of the left upper central incisor, which was found, upon inspection, to be impacted between the floor of the nose and the roof of the mouth."

Dr. Huey of Philadelphia records a case in which there were in a patient's mouth "thirty-five small supernumerary teeth within the alveolar process in the space which should have held the left central incisor. After removing

Fig. 672.—Impacted lower third molar. Part of the distal root of second molar has been resorbed, exposing the root canal thus producing neuralgia. The mandibular nerve is also irritated by pressure. (*Cryer.*)

the supernumerary teeth, the permanent normal incisor could be seen resting between the plates of bone forming the roof of the mouth and the floor of the nose."

Fig. 674 is a photograph from a skull in Dr. Kirk's collection that affords a good idea of the general condition in the mouth of Dr. Huey's patient.

"The permanent central tooth was not removed with the supernumerary teeth in this case, as Dr. Huey and the writer had some hope that it would assume its normal place with the other teeth. Six months after the operation the tooth had advanced more than half its length and, at this writing, eighteen months afterward, it is about in its normal position."[1]

Impacted Permanent Teeth.—Of the permanent teeth, those most frequently impacted are the *third molars*, particularly the inferior third molar.

FIG. 673.—Impacted lower third molar. (*Cryer.*)

In the development of the mandible, the first permanent molar is developed in the body of the bone, about the sixth year, a little anterior to the ramus. As the body of the bone lengthens in its development, the second molar also appears, just posterior to the first and in front of the ramus. The body lengthening still more in its growth, the third molar erupts posterior to the second and directly in front of the ramus. If, however, the body of the bone fails to lengthen sufficiently to admit of the normal eruption of the third molar, it may take a position with its occluding surface directly in contact with the

[1] Cryer, page 125.

posterior surface of the second molar, while its roots extend backward into the ramus of the bone. The tooth thus lies in a horizontal position, nearly or quite parallel to the lower border of the bone (Figs. 675 and 676). A tooth in such a position may cause extreme discomfort by reason of pressure directly upon the third or mandibular branch of the fifth nerve. It may readily be seen that the root-ends of a tooth in such a position may come in direct contact with this large nerve and thus cause neuralgia. It may, by reason of its pressure, cause extensive swelling, involving the surrounding soft parts. Such teeth, however, frequently remain impacted through life without causing any disturbance.

FIG. 674.—Skull of a child about six years of age, showing all the deciduous teeth in position and the developing permanent teeth. (*Cryer.*)

The next tooth which is subject to impaction is the *cuspid*. The cause of impaction of this tooth is usually the premature removal of the deciduous cuspid.

Importance of Deciduous Cuspid.—It is of great importance to retain the deciduous cuspid instead of unwisely extracting it. To remove this tooth before it is time for the eruption of the permanent cuspid is to encourage the moving of the lateral incisor backward and the bicuspid forward until they meet, after which the cuspid, in its efforts to erupt and take its place, finds no room. It may, therefore, become impacted in the bone or diverted into an abnormal position, either lingually or labially, producing a dental deormity. The operator, once having committed the very grave mistake of emoving a temporary cuspid, frequently resorts, after a permanent mal-

posed cuspid has erupted, to the unjustifiable and untimely extraction of this tooth.

In his work on "Internal Anatomy of the Face," Prof. M. H. Cryer, in describing impacted teeth, says:[1] "If the action of this process be interfered with during the development and eruption of the teeth, their normal arrangement will be modified in proportion. Interferences causing impaction can

FIG. 675.—Impacted lower third molar. (*Shearer.*)

often be attributed to many diseases of children, such as scarlet fever and other constitutional disturbances which cause inflammatory conditions in and about the jaws." Fig. 674 is taken from Prof. Cryer's book and, in its description, the author says:

"A general idea is given of the arrangement and position of the teeth, deciduous and permanent, and of their relations about the sixth or seventh year. The external walls of the alveolar process of the upper and lower jaws have been removed, together with some of the cancellated tissue, exposing the roots of the deciduous teeth and the crowns of the permanent

[1] In Chapter on "Interferences with Development."

ones. It will again be noticed that at this age nearly all the space of the maxillary bone is occupied by the dental organs, there being but little room for the maxillary sinus. It would seem clear that, by interference with the natural processes at this period of life, the permanent teeth can be deflected

FIG. 676.—View showing impacted molar turned out of its pocket. (*Cryer.*)

or detained from assuming their normal position, thus modifying the maxillary sinus or nasal chamber. When these chambers are changed in form, size or position, associated cavities and adjoining structures will also be changed. The shape of the orbit may also be modified to such an extent that the eye may be affected, making it myopic or hypermetropic."

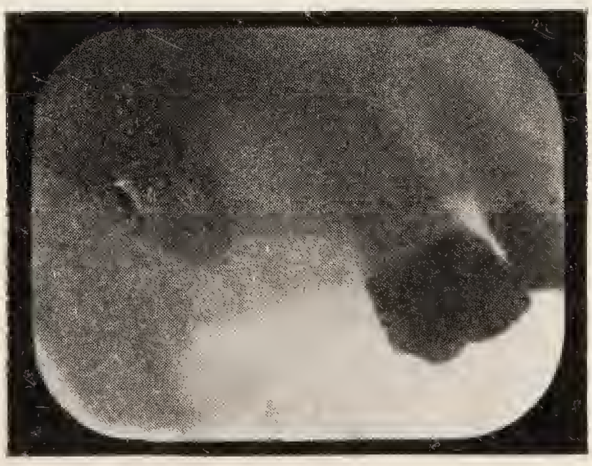


FIG. 677.—Third molar tooth, the crown of which is directed backward and upward into the sphenoidal fissure. (*Shearer.*)

Nutritional Changes.—"There are two opposite processes associated with inflammation within the jaws; one destructive or suppurative, causing the breaking down of the tissue; the other a constructive or building-up and

hardening process, through which the cancellated tissue is transformed into hard and dense bone. Through undue hardening of the bone before complete eruption of the teeth, they become incased with their capsules in the surrounding bone, under which circumstance it is impossible for the eruptive force to carry them into their proper positions. They are often held in the place of development or pushed in the direction of the least resistance until resorption of the bone-tissue occurs, when they usually make their appearance in an abnormal position."

Position of Supernumerary Teeth.—A supernumerary tooth, or any tooth which fails to take its proper place in the dental arch, may assume any place in

Fig. 678.—An odontoma and an impacted central incisor tooth. (*Cryer.*)

the maxillæ or mandible. Of the upper teeth, the diverted tooth may pass into the nose or into the antrum of Highmore; it may take a course backward and pass, partially or completely, into the spheno-maxillary fissure (Fig. 679); it may pass upward into the orbit or through the anterior plate of the bone; or it may take an outward direction, passing through the external plate and, in some instances, making its exit through the cheek (Fig. 680). These teeth may be found in the hard palate, sometimes perforating it, or they may pass through the alveolar process either anterior or posterior to the natural alignment of teeth (Figs. 681 and 682).

Upon interference with the nerves and vessels with which these drifting teeth come in contact, it is easy to see that marked disturbances will ensue. If the teeth come in contact with vessels, disturbance of the circulation results; if with the nerves, neuralgia.

Position of Impacted Teeth.—Impaction occurs most frequently in the angle of the jaw, as in the case of third molars. The tooth may take a horizontal position in line with the body of the bone; it may extend backward and upward with its enamel surface downward and the roots upward (Fig. 683); or the position may be quite the reverse, with the enamel surface upward, extending into the sigmoid notch. There it becomes a source of irritation to the surrounding parts, often establishing a temporo-mandibular arthritis.

FIG. 679.—A skiagraph showing the third superior molar tooth erupting in the spheno-maxillary fissure.

Impacted teeth may be centers for the formation of cysts, which cause extensive absorption of surrounding bone. (See Chapter on Cysts.) They may also become centers of infection and the exciting cause of caries or necrosis of bone.

Diagnosis of Impaction.—Diagnosis of an impacted tooth from the normal denture may be begun by carefully noting the number of teeth present and the absence of any permanent tooth. Complaints made by patients, when disturbance is caused by impacted teeth, depend upon the character of the irritation. If it is in the form of neuralgia, the patient will describe all the char-

acteristics of the affection. If from general inflammation of surrounding parts, without marked neuralgic pains, the swelling and throbbing pain characteristic of inflammation will be noted by the patient. If the impaction has

FIG. 680.—Impacted upper third molar. (*Cryer.*)

changed the normal alignment of the teeth, this, of course, will be observed by inspection. If it has caused carious or necrotic destruction of the bone, this may be determined by the use of exploring instruments. The most

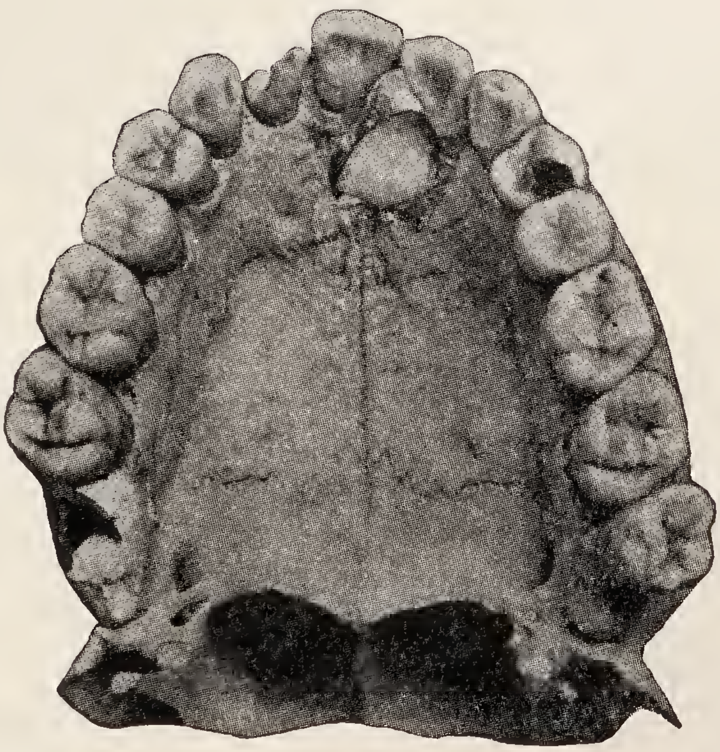


FIG. 681.—Impacted central incisor with the crown partly in the anterior palatine fossa. (*Cryer.*)

reliable means at our command, however, with which to determine the presence or absence of impacted teeth is the Röntgen photograph. The exact outline and position of a tooth can be defined thereby, provided the operator

is skillful. Having located the impacted tooth, which is the center of a disease, we should remove it as early as possible.

Operation on Impacted Teeth.—The removal of an impacted tooth calls for the highest degree of skill. Unfortunately, the laity does not understand

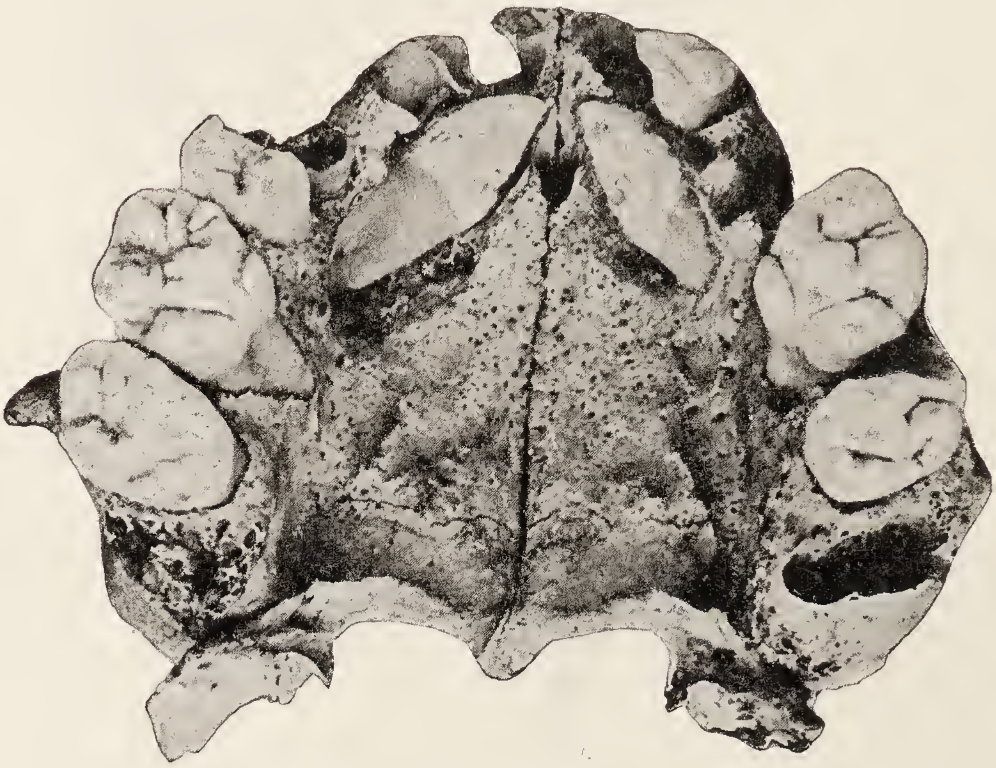


FIG. 682.—Impacted cuspid teeth. (*Cryer.*)

that the removal of such a tooth, no matter how situated, is more difficult than the usual extractions. To remove a cuspid, lying in an angular or horizontal position in the substance of the bone, requires considerable time and a thorough knowledge of the anatomy of the parts so as to avoid injury to the nerves, vessels and adjacent teeth.

FIG. 683.—Impacted lower third molar. (*Cryer.*)

It is unwise to remove a second molar with a view to relieving the inflammation established by the malposed or impacted third molar, for the second molar is usually a good tooth with correct occlusion with the opposite molar and the assistance it gives in the function of mastication is valuable. Its

removal deprives the patient of an important part of his denture. Should the malposed lower third molar came forward after the removal of the second, it will be of little or no use for masticating purposes, not being likely to take an upright position and occlude with the upper teeth, but continuing to lie in a horizontal or nearly horizontal position. The removal of the second molar also weakens the jaw to such an extent that fracture is more apt to occur in difficult removal of the third molar.

The removal of a third inferior molar, deeply impacted into the substance of the bone, as in any of these operations for the removal of impacted teeth,

Fig. 684.—Unerupted third molar.

should be made under general or local anesthesia, preferably in a hospital. The overlying bone should be removed and the tooth carefully lifted from its socket by means of elevators. Suitably formed forceps may be employed after the tooth has been loosened by the elevators. If the cusps of the third impacted molar interlock or lie beneath the bulging enamel of the second molar so as to interfere with the elevation of this impacted third molar, the operator should cut away the overlying bone and employ a carborundum stone with a dental engine, cutting away the cusps of the tooth to be removed so that its upward passage will not be interfered with by the bulge of the enamel of the second molar.

The operator must bear in mind that the bone has been greatly weakened by the malposed tooth occupying so much space, and the cutting away of the amount of bone necessary to expose the tooth weakens it still more. Extreme care, therefore, should be taken to avoid the use of undue force in

dislodging the tooth. There are many cases on record of mandibles fractured in removing an impacted third molar.

FIG. 685.—Common form of impacted lower third molars. (*Cryer.*)

FIG. 686.—Right half of mandible, clearly showing cancellated tissue and dental canal. The foramen is well shown. A rudimentary fourth molar is well illustrated. (*Cryer.*)

I regard the Physic forceps as absolutely unsuitable for *removing* either an upper or lower third molar, although they may be successfully used as an aid

in extracting those lower third molars whose crowns are in normal position. In using the forceps for this purpose, they should be merely closed between the second and third molars without leverage. They should not be used, however, in impacted cases, as with this instrument the force is directed backward and the leverage is not of an uplifting nature. An elevator, as its name

FIG. 687.—Impacted third lower molar and a lower third molar with curved and thickened root, both belonging to the same jaw. The bone is much more compact than normal bone. (*Cryer.*)

implies, should be employed as an *elevator*, not as a lever to exert force backward.

It is important to make a sufficiently large exposure of the overlying bone in order to insure a good view of the field of operation. The best instrument with which to expose the imbedded tooth is the dental or surgical engine and suitably formed burs. My observation has been that generally too little

bone has been removed instead of the amount necessary to enable the operator to dislodge the impacted tooth. The upper third molar, impacted in the bone, lies in the disto-inferior wall of the antrum and, during its removal, the posterior wall of the antrum, together with the tuberosity of the bone, may be carried away unless great care be used. The bone should be liberally exposed to view and the overlying surface removed, when the impacted tooth should be carefully dislodged. The force should be so directed as to avoid fracturing the tuberosity. In removing supernumerary teeth which are impacted, the same general rules should be observed. Care should be taken during the extraction of an impacted tooth lest, after its removal from the bone, the tooth should fall into the pharynx, enter the trachea and cause suffocation, or an upper third molar may be thrust into the antrum, where its removal may be attended with great difficulty.

FIG. 688.—Showing a molar tooth in the ramus of the mandible. There is a light area around the greater portion of the crown. (*Cryer.*)

Post-operative Treatment.—The condition of the parts after the removal of impacted teeth, especially the third molars, may require careful attention, for it must be borne in mind that the close proximity of the posterior dental nerves in the case of the upper jaw, and of the mandibular nerve in the lower, expose these nerves to the possibility of injury. The removal of the teeth, therefore, makes care for the patient imperative until the wound is healed. The pain following the removal of these teeth is sometimes more severe than it was before the operation, at least for a few days. One should keep the cavity irrigated, free from secretions, particles of food, etc., and pack it lightly with medicated gauze, using a menthol solution for relief of pain. An aseptic condition of the mouth should be maintained as far as possible by frequent rinsing with a hot antiseptic solution. In a measure swelling may be controlled in this way, also by the use of hot fomentations.

FIG. 689.—Lower second molar which emerges from the lower border of the mandible. Two-thirds of its root has passed through the bone while the enamel is still embraced within it. The third molar is also imbedded in the bone. Teeth in this position should be removed intra-orally.

FIG. 690.—Inverted third molar in the mandible.

CHAPTER XXXIII

TRANSPLANTATION OF TEETH INTO ARTIFICIAL SOCKETS IN CONNECTION WITH PERSISTENT VITALITY IN TEETH LONG EXTRACTED AND OTHER TISSUES

BY

WILLIAM J. YOUNGER, M. D.

PARIS, FRANCE

Transplantation of teeth into artificial sockets, or the "Younger Operation" as it was then called, but now known as "Implantation" (the name the author himself gave it in a paper presented at the Ninth International Medical Congress held in Washington in 1887), is an operation consisting in the formation, surgically, of an alveolus or socket in a jaw, from which a tooth has been long extracted or which has always been edentulous, into which a tooth can be fitted and domiciled. At this same Congress Dr. Younger demonstrated the operation by implanting two lower incisors in the mouth of an English dentist, and the operation was pronounced by Surgeon General Hammond, the President of the Congress, as "the original operation of the Congress!"

Short History of the Operation.—The first implantation made was on January 17th, 1885, for a young lady of twenty-four, who had been wearing a plate for four years—a left superior lateral. This was followed in August and September by the implantation of three superior bicuspids in a lady of thirty-five, who had lost these teeth twenty years before. Subsequently this same lady had another bicuspid and a molar implanted. These teeth were all freshly drawn and planted immediately in the artificial sockets, it then being believed necessary for success that no time should be lost between the extraction and the planting.

At first the author believed that it was absolutely necessary to implant teeth which were freshly drawn and often he had to extract good teeth, which were wasted for want of an opportunity for immediate transplantation. He tried planting them in cock's combs to preserve their vitality, but would the teeth stand another operation? On November 28th, 1885, he transferred a biscuspid, which had been in a cock's comb for twelve days, to a gentleman's mouth, where it fastened itself as if there had been no gallinaceous period in

its existence. After this, no teeth that could be planted in a cock's comb were wasted.

Discovery and Importance of "Persistent Vitality" in Tissue.—One day it occurred to the author, while examining a tooth that had been extracted over a year (being the supposed cause of a persistent neuralgia) and which the owner was very anxious to have restored to her mouth, that, perhaps, in the dry, shrivelled membrane which covered its roots there might be some latent or dormant vitality whose energies might be awakened if placed in living sanguineous connection. Partly to oblige the lady, but principally to test the idea that had inspired him, the author, after soaking the bisucpid in warm, sterilized water, restored it to the socket from which it had been extracted over thirteen months before. This was on March 11th, 1886. Ten days after the operation, the tooth being very comfortable, the lady, in a moment of abstraction, bit into a crust of French bread. Pain, loosening and bleeding ensued. The next morning she presented herself, crying and disconsolate, saying the tooth was lost. On examination it was found to be quite loose, but, gentle traction being made to remove it, the author was surprised to find that the tooth resisted the effort. A closer examination showed that the encircling gum was attached to the neck, thus proving that a vital union had taken place between the old, dry, shrivelled membrane and the tissue of the artificial alveolus, thus justifying the inspiration that led him to plant the tooth. It also revealed the startling discovery that tissue did not part with its vitality upon its disconnection with the blood source and that, when brought into proper relation with its natural nutriment, it would revive its energies and again vegetate and functionate. Henceforth the troublesome cock's comb was discarded and the extracted teeth were laid by carefully until required.

Necessity of Vital Connection.—The way in which the pericemental membrane acted in this case, and in other similar operations where the tooth became attached and showed a bleeding surface after re-extraction, indicates its importance in determining success. In selecting teeth, therefore, the author was careful to use only those which had a fair or, at least, some pericementum, which were not diseased nor presented signs of previous inflammation, and which, moreover, showed that the pulp and the tooth throughout had been in perfect health at the time of extraction. To obtain this result, he often took the root of one tooth and attached it to the crown of another. However, within the last few years he has been obliged to employ teeth that barely had pericementum, if any. Notwithstanding, the results have been successful generally. In these instances the endosteum, which is the continuation of the pericementum into the canaliculi, supplies the loss of its mother membrane by proliferation, and it is quite capable of restoring the pericementum, if not entirely, at least to a sufficient degree. The pericementum, therefore, while not absolutely necessary to success, facilitates success.

In further proof of the truth of which may be called "persistent vitality in tissue," the following case is cited:

Dr. Barger, at the time Health Officer of San Francisco, came to the author for three implantations. During the Civil War he had the two superior centrals and the right lateral knocked out by a fragment of an exploding gun, carrying with them part of the alveolus. The teeth employed had been extracted five years. One, the left central, had a longitudinal crack extending from the cutting edge to the cervix, and it was due to this disfiguring mark that it had not been used previously, but the author had no other that would match. The doctor urged that it was not for beauty, but for use, that he wanted the teeth. However, the crack commenced widening and lengthening and, while the author was absent in Europe, the tooth split high up. The left, which was the loose half, was retained simply by a fleshy attachment. The doctor tied a silk ligature around the two halves and so kept the left, or loose, half in position until the author's return. Having found another central, the implanted tooth was extracted, first removing the loose portion by cutting it from its attachment. Notwithstanding the utmost care, the solid portion of the root broke high up. On this portion, as well as upon the loose one, there seemed to be a perfect pericementum. In order to determine positively whether this was so or not, a microscopist who had come to San Francisco lately was sent for. He was recommended highly by Professor Jonathan Taft, Dean of the Ann Arbor Dental Department, University of Michigan. This gentleman had, at a previous meeting of the San Francisco Dental Society, pronounced himself strongly against the author's theory of persistent vitality in tooth tissue, saying that immediately after a tooth was drawn, it became dead and impossible of revivification as he had never seen any evidence of prolonged or continued life in such teeth. With his prejudice against the theory if, after a thorough investigation, he should decide that the membrane, which seemed to be pericementum, was such and that the life-like appearance of the cementum and dentin were due to vitality, then the author could rest assured of the truthfulness of his doctrine.

When Dr. Jacobs saw the pieces of root, he became intensely interested. The result of his investigations and the story told by the two slides he prepared are as follows:

"San Francisco, California,
November 23, 1891.

Doctor William J. Younger,

Dear Sir:

I have carefully examined the specimen of implanted tooth you gave me and find the pericementum firmly attached to a part of the tooth near the cervical portion covering quite a large portion of the cementum. A part of the tissue was detached and mounted on a separate slide. It has been shrunken considerably by the use of clove oil and a little overstained by acid

carmine, but, for all that, shows structure very nicely. The dentin and cementum were not blackened, to my surprise, as is always the case in a dead tooth. This indicates that the tissues (hard as well as soft) were still alive.

Very truly,
(Signed) F. O. Jacobs."

Of course, if the fact of renewed vitality has been discovered in one single instance, it is sufficient to establish the theory, for the failure to prove this in other investigations only shows that the conditions were not proper and, therefore, not to be considered as relevant.

Results of Fredel's Experiments.—In a long series of experiments in replantation and transplantation of teeth in dogs' mouths, conducted by Leon Fredel at the Laboratory for Normal Histology at the University of Geneva, and reported by Michael Morgenstern, of Baden Baden, in the Vierteljahrsschrift für Zahnheilkunde, the fact was proven that absorptive action did not occur in teeth protected by pericementum, also that, though frequent, it did not occur necessarily in those portions of the teeth from which this tissue had been removed. He demonstrated by these experiments that the presence of pericementum is absolutely necessary for obtaining a permanent and firm union and that this union is a nutritious one; also that, in some cases, after resorption had been established, the process became stationary. He found that attachment begins about the body of the tooth, thence proceeds towards the apex, which he considers favors success by preventing infection of the root. He says: "Periosteal attachment is re-established in a comparatively short time. In Case 7, within seven days the parts had acquired such a union and the circulation had been so well established that if we had not injected cinnabar it would have been impossible for us to discover the line of rupture. It showed an infiltration of a quantity of young cells, most probably arising from two different sources: 1. In consequence of the immediate regeneration of the cells within the tissues; 2. in consequence of the immigration of foreign cells, this infiltration causes the original fundamental tissue to disappear. However, it is regenerated later on.

It is absolutely necessary for every transplantation that a vital connection be established in a short time. Whether the original blood-vessels regain their vitality cannot be proven, but, in every successful case (and this is a fact), new vessels were formed which could be recognized by their thin fragile coats. The enormous hypertrophy of the periosteum is caused: 1st. By the return of the periosteum to its embryonal condition; 2nd. by an extensive resorption of the alveolar bone.

During the act of normal teething, analogous phenomena are observed, viz: extensive resorption and regeneration of osseous tissue. As soon as the pericementum has been regenerated, the process of resorption stops. The consolidation is promoted greatly by the dilatation of the Haversian canals, through which a free communication with the gum is established. In every

one of our cases consolidation was due to the renewed vitality of that part of the periosteum which had remained attached to the root. Whenever a portion of the pericementum of any part of the tooth has been destroyed, resorption will begin at this place and form Hoswhip's lacunæ. Sometimes it will become stationary soon, which is recognized by the fact that the lacunæ contain no osteoblasts, but fibrous tissue with a few blood-vessels."

The author firmly believes that revitalization takes place in the pericementum, the cementum, the interglobular substance through its corpuscles and in the dentinal canals. In this way may be explained the fact that sensibility returns occasionally to the hard tissues of old implanted teeth, the cementum at least.

Every animal tissue has an inherent independent vitality; the blood is simply its pabulum, from which it draws those elements necessary for its characteristic growth, development and repair. When separated from the blood or its endosmotic neighborhood, it is simply rendered incapable of performing those functions, and, as its vitality was not derived from the blood, neither does it yield it necessarily with its loss. Tissue is dependent on the blood only for the necessities of its organization and in proportion to its needs and activity. For instance, the brain and nervous matter, more than all other tissues, being in a state of constant activity, require the blood to supply the immediate waste which activity necessitates, but bones, ligaments, tendons, membranes, etc., starve slowly and, being comparatively inactive, they can, therefore, prolong their vitality indefinitely.

The pericementum, after it has performed the function of perfecting the cementum, becomes a tissue to connect the root it invests with the environing walls of its alveolus. For the exercise of this simple duty it requires but little blood. The author's theory of the persistent vitality of the pericementum contains nothing wonderful. The whole theory of the spread of epidemics, contagious and infectious diseases, lies in the ability of the noxious germs to preserve their vitality through years of dessication, only to revive their pestilential energies when conditions are favorable.

Description of the Operation.—To illustrate how the operation should be performed, we will use the annexed diagram:

A.B. (Fig. 691) represents two teeth between which a socket has to be formed for the reception of a tooth.

C.D., the dotted lines, represent the contour of the buccal and palatine surfaces of the gum.

E′.E.F′.F. are the terminal points of the incisions.

Between the incisions and the teeth there should be a full half millimeter of gum to act as a layer for proliferation and attachment of the flaps. Begin by making all the incisions light, to establish the line of the cut or division. Commence at *E* and carry the knife to *F*. Repeat on the opposite side. Then make the curved cross cut *G*. The upper line of the curve should be about one-third from a line running in front of the teeth. This is in order to

gain length of gum to cover the cervical front of the root to be inserted. In making the incision at the terminal points, great care should be taken not to remove any of the gum. The line being established, the incision should be carried to the bone. The flaps now being well separated, they should be dissected away from their attachment to the bone as far as the insertion of the muscles, and, in doing so, pick up little points of periosteum. Thus, when the gum is lifted from the alveolus, it will be, in its whole extent, on a plane with the gum covering the adjoining teeth. By this incision we obtain the same thickness of gum over the new tooth that is possessed by the other teeth and we secure sufficient prolongation to bring it to the marginal line of the adjacent gum.

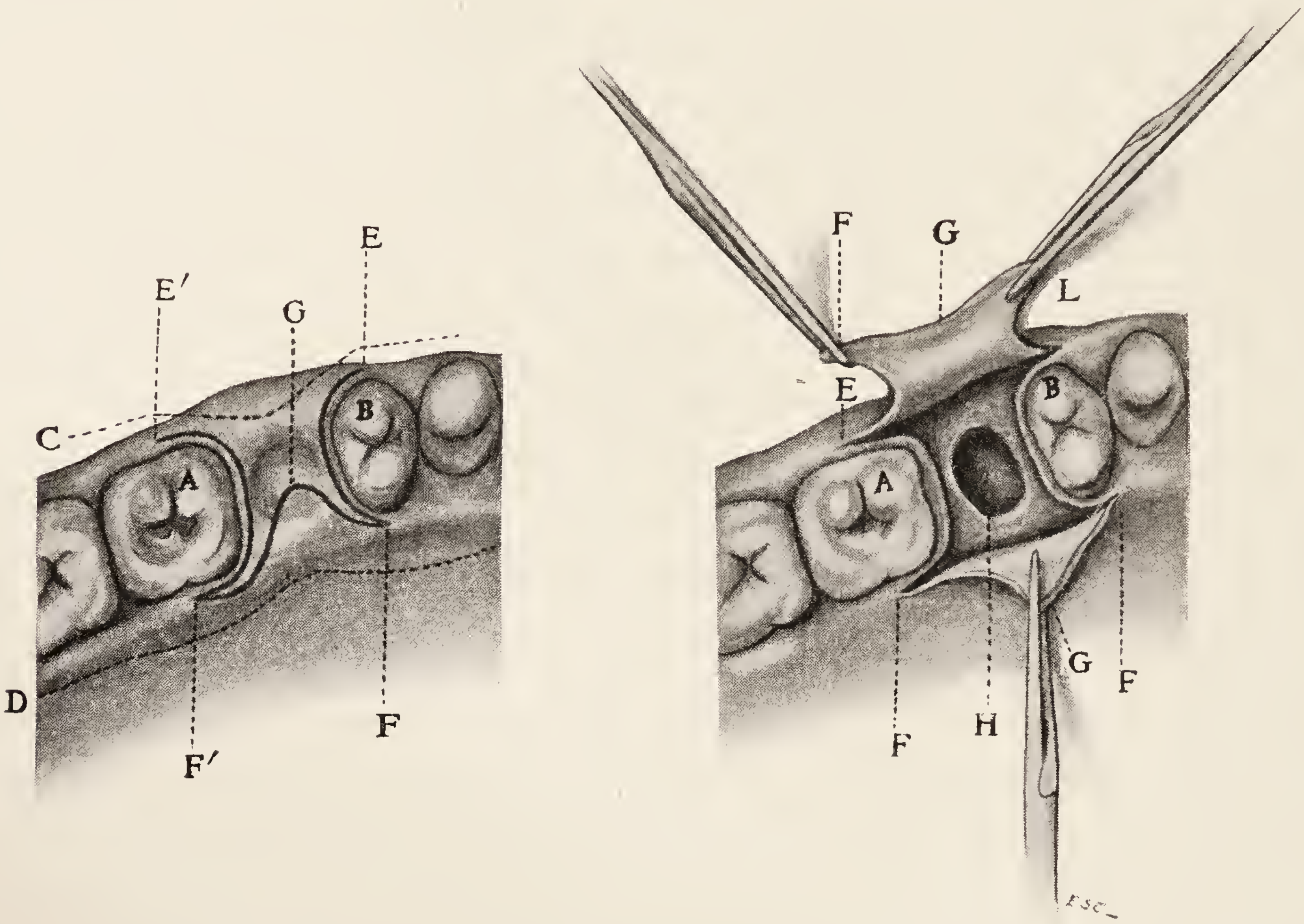


FIG. 691.—Younger operation for the implantation of a tooth. See text for explanation.

The buccal portion should now be raised, the trephine fixed on the center of the edge of the alveolar process and drilling commenced in the direction of the line which the tooth is to occupy. Having secured the necessary depth, the cavity is enlarged and fashioned to conform to the shape of the root. This being perfected, the tooth is inserted. Should the tooth be loose in the socket, it should be ligated to the adjoining teeth and these ligatures, as a matter of precaution, should remain for two weeks, at least. Care must be taken to prevent the removal of the pericementum from the root in the process of fitting the tooth, also excessive impingement on the tooth when the jaws are occluded. Variations from these rules will be necessary in peculiar cases, which every skillful operator—and no other should attempt this operation—may easily recognize for himself.

Instruments and hands have to undergo the usual antiseptic treatment. By the experiments of many authors, we know that in animals no mechanical or chemical injury to bones will excite an acute suppurative inflammation, but that it will follow bacterial or putrid infection immediately. Occasionally it has happened, both in the author's practice and with others, that the antrum has been penetrated, but no serious result has, so far as is known, followed such antral perforation. In his practice, the penetration of the antrum made no appreciable difference on the result of the operation.

As to the ultimate success, it ought to be measured, in the words of a colleague, "not by a lifetime, but by a few years. We often consider an operation successful which has lasted for a year, and there are patients who are willing to undergo the operation of implantation once a year in preference to wearing any artificial substitute. An operation may be successful, if not the first time, the second or third time."

The chief difficulty in the way of implantation lies in the lack of proper material: *artistically*, the crowns, especially of the incisors, must resemble the teeth they are to adjoin in size, shape, shade and contour; *surgically*, the root must be perfectly healthy, of the proper length and thickness, be straight or nearly so, and should have some covering of pericementum. To produce a tooth like this, the crown of the tooth has to be joined to the root of another by means of gold or platinum pivots and cement. The joint should be made so perfect that if it should lie outside the gum it would not be noticed and, if underneath the gum, there would be no projecting edge to irritate the tissue in contact. Success has sometimes been obtained with teeth that had no observable membrane, showing that, while pericementum is not absolutely necessary, yet its presence facilitates success. In these cases the attachment takes place by proliferation from the endosteum lining the canaliculi, which is capable of re-investing the root with pericementum, the same as it does in reproducing periosteum on new formation of bone.

Usually the tooth becomes solid and fit for the purpose of mastication in from four to six weeks. This depends very much on the amount of bone surrounding the root and the condition of health or vigor of the patient. In the case of the young lady who kindly presented herself at the International Medical Congress held in Berlin in 1890, where a stunted upper jaw had been built out and developed to artistic proportions by planting in grooves made on the outer ridge of the bone nine teeth to one-half of their depth, and stretching the gum over the roots, it took about five months before they were fixed sufficiently for use in mastication. The author has a patient now in whom four front teeth have taken eighteen months to two years before becoming solid. In this case, had all the circumstances been known, the author could not have been persuaded to perform the operation. The lady lost her incisors from dento-alveolitis. As the teeth were perfect, her dentist cut off the roots and mounted the crowns on a rubber plate, fastening the denture by clasps to the bicuspids and molars, which had also commenced

to suffer from dento-alveolitis. For four years she wore the plate which was, by that time, loosening and making painful the teeth to which it was attached. Then she came and insisted upon having an implantation.

Caution about Operating on Tissues that have been Subjected to Burns.—There was, of course, considerable recession of the gums, but, almost worse than this, they had undergone that burning process which is so popular (or, at least, was so with the French) and which it was believed would cure dento-alveolitis. The vegetative energy of the gums and ability of proliferation and forming attachments are destroyed by that process. Whatever failures and difficulties the author has had, both in implantation and dento-alveolitis, have been due to the igno-punctures these tissues have been subjected to. In the case of Dr. T., a celebrated occulist in Paris, who had been subjected to this painful and ineffectual treatment, the author labored with the gums for four years before they became active and proliferated sufficient tissue to hold the teeth solidly in position, therefore, it has become a habit for several years back, either for planting or dento-alveolitis, to refuse to undertake the care of any mouth which has been subjected to this treatment until the patients are made to understand that, while the disease certainly will be cured, the teeth may not become either attached to their sockets or firm in their alveoli. Not having suitable teeth, the crowns from her plate were removed and roots attached to them. Singularly, they seemed so solid after being planted that it was not deemed necessary to put on a retaining plate. Strings only were attached to them to forestall an accident. In about two weeks they began to loosen in their sockets. On examination, it was found that there had been but slight gingival attachment and their firmness had been due to the tightness with which they had been fitted into the sockets. There must have been some vital attachment as they did not drop out, which would have been the case if such an attachment had not been effected. A retaining band was then put on. They did not all become firm at the same time nor near the same period. At the end of one year the left superior central only was firm; the right central and lateral were loose, but tightening evidently, while the left lateral was so very loose that it was removed. The root was found to be much absorbed and another one was substituted. At eighteen months the retaining band was removed again; the right lateral was found to be firm, but the right central and left lateral were still somewhat loose. At the end of two years these teeth were solid enough for the plate to be left off.

The right cuspid and first right bicuspid will now be removed. The latter tooth was planted two years ago, but has never become tight. The cuspid has an apical attachment only and its front has been almost entirely denuded of gum. These teeth have been held in position only as a temporary means of support to the front teeth, therefore these teeth will be removed now, their sockets freshened and deepened and other teeth planted in their stead.

Report of Specially Interesting Cases.—CASE NO. 1.—Choveni, a child of ten. She was brought June 3, 1911, to have a very ugly projection of her superior incisors reduced. The centrals projected on a plane nearly at right angles with the line of the face. The only teeth of the permanent set erupted were the incisors and the sixth-year molars. These had grown to the level of the deciduous molars, but they left the lower centrals pressing into the palate half an inch behind the gingival line of the upper incisors when the mouth was closed. This presented a mechanical obstruction to draw in the upper teeth. To overcome this difficulty, gold caps were made, fitting over the second deciduous molars and projecting a millimeter and a half, thus elongating the crowns and making a space between the permanent molars into which they might grow and thus keep the *bite* elongated when the crown of the temporary teeth should drop off. On each of these crowns two gold loops or rings were soldered, one on the buccal and the other on the palatine surface for the attachment of strings to bring retracting pressure on the centrals. The day after the strings were put on, while attending church, the child swooned. In falling, she struck her face on the marble floor, knockng out her two centrals. The teeth were brought to the author in an envelope twelve hours later. They were clean and the roots nearly perfect, except the apical foramena were still unfinished. The question was whether or not to remove the pulps. If they were not removed, there was danger of decomposition; on the other hand, if the pulps were removed, the internal growth of the teeth would be impossible and the roots would be left in part as fragile and thin as an egg shell. It was decided to give the teeth a chance to develop themselves fully. After soaking them for half an hour in 1–5000 solution of bichloride of mercury and freshening the surfaces of the empty alveoli, the teeth were gently introduced until fitted into their natural position. Then they were tied to the adjoining laterals and left for twelve days, by which time they were quite solid and the gums well attached around the necks. The regulating strings were replaced and, in the course of four weeks, July 16, 1911, all the teeth had been drawn into artistic position and the retaining appliance adjusted. The teeth have not undergone the slightest change in appearance and light thrown through the crowns fails to find any discoloration. In moving the teeth, the sockets followed the roots the same as if they had never been disturbed from their setting. The only difference that can be detected between the incisors is that, while the laterals are very sensitive to heat, the centrals are callous to it. This may seem to indicate to many that there has been no union between the pulp and the tissues from which it was torn, but sensitiveness to thermal changes is not necessary to a union of tissues. Have you never been surprised by finding a nerve alive in a tooth which you had presumed "dead" because it had not responded to a test of heat and cold? The author is firmly assured that a normal connection has taken place between the pulps (pulp sacks) of those

teeth and the tissues outside of the apex, the same as has taken place between the pericementum and the environment of the roots.

Case No. 2.—Paris, November, 1905. Mlle. Cavmen, twenty years of age, a native of Brazil, well developed, strong and healthy. Notwithstanding her youth, the majority of her teeth were very badly loosened by dento-alveolitis. Her dentist, not being able to effect a cure, extracted the four lower incisors. Six weeks later she came to the author, with the extracted incisors, for consultation. The contraction which had taken place did not permit of more than three teeth being inserted. We were able to utilize part of the sockets of the laterals, but the alveolus of the middle tooth had to be made between the almost extinct sockets of centrals right in the symphysis, thus reducing the necessary depth of the artificial alveolus and reducing its chance for fixation (Fig. 692). The result was that another tooth, a

Fig. 692.—Case 2, lower jaw. Teeth implanted Nov., 1905. Skiagraph taken Oct. 27, 1913. (*Younger.*)

Fig. 693.—Case 2, upper jaw. 1. Implantation, 1906. 2. Same. 3. Tooth removed in consequence of morbid roots. Roots polished and replanted. (*Younger.*)

stranger, with a longer root had to be employed instead of the original tooth. It is now ten years since these operations were made.

The right frontal side, constituting the right central and center of the upper arch, of this same young lady was so depressed that the right central incisor fell inside the line of the lower incisors. This was due to the early loss of the right canine and lateral, the space between the bicuspid and the central having closed up. This depressed portion was raised and drawn toward the left by ligatures from the left side so as to place this portion in proper relation with the lower, and also to make a space between the central and the first bicuspid. During this process, the first bicuspid, having a badly decayed crown and a diseased root, was extracted and a dummy tooth inserted to keep the formation of the root intact until the tissues of the socket should become healthy, at which time the bicuspid was inserted with the idea of changing it later for a canine, which was not obtainable then. When suf-

ficient space was created between the central and the cuspid, a socket was formed surgically and a lateral implanted. After a time the right central elongated and resisted all efforts to keep it in its socket, indicating erosion of its root. The crown also became dark, therefore the tooth was extracted, the dead pulp removed, the canal and chamber, as well as the whole tooth, sterilized and the canal filled. The absorbed roughened end of the root was smoothed and polished and the alveolus freshened by rubbing with a small ball of cotton saturated with lactic acid. The tooth was reset, where it fastened itself and became solid (Fig. 693). Three other operations were done for this young lady. The first left upper molar, the first right upper molar and the right lower molar were so elongated and their roots so heavily incrusted with deposits that they were each extracted in the order named and at different times. The roots were thoroughly scraped and cleaned, the pulps removed, etc., and the teeth re-inserted. Thus this young lady holds the banner in Europe with four implantations, four replantations and one transplantation.

FIG. 694.—Implantation of first right lower bicuspid. Thirteen-year-old tooth. Apices wide open and pulp sac intact. Implanted Oct. 17, 1913. Skiagraphed Oct. 27, 1913. (*Younger.*)

CASE NO. 3.—Mlle. Olympia de C. In this mouth the root of the first right upper bicuspid, which had been crowned, was found to be split transversely. It was decided to remove the tooth, but the roots were so tightly wedged (it being absolutely necessary to preserve, for appearance's sake, the margin of the buccal alveolus) that it became necessary to drill them out. The tooth transplanted was from a thirteen-year-old child. The ends of the roots had not fully formed, but were quite open, very thin and delicate. They were well filled with clean, healthy pulp tissue; in fact, the whole tooth had such a clean, healthy look and the roots a good covering of pericementum that it was determined to plant the tooth just as it was, trusting to have a vital attachment made with the pulp and a restoration of its trophic and vegetative energies. This tooth, if it remains, shall be kept under observation and skiagraphs made at various times to note if resuscitation of the pulp takes place and the apices of the roots are formed (Fig. 694). It must be

said that the patient was informed beforehand of the condition of the roots and the possibility of the pulp dying or decomposing, necessitating the removal of the root with the substitution of another tooth. For the sake of science she accepted the conditions.

The difference in the Choveni teeth and the one planted for Mlle. Olympia lies in this, that the Choveni teeth were fresh and planted within twelve hours of the time at which they were knocked out, while the one planted for the young lady had been out of sanguineous connection many months, at least. As pointed out in the Gazette of 1880, the reparation in the structure of the alveolus, as in the reparation of any other bony structure, is by means of the endosteum.

Conclusions.—The author has lost sight of the cases in which implantations were made eighteen years ago. However, a patient, who had had two teeth implanted on September 6, 1886, reported in 1904 that the teeth were in perfect condition.[1] Indirectly other cases implanted about the same time were reported to be in excellent condition. When the author first introduced implantation, he thought he was giving the profession and their patients an operation which would last a lifetime. He still believes it an operation capable of this longevity where the conditions are perfectly complied with; that is, when the tissue-health and vigor are good, the organization and structure of the tooth to be planted are perfect, and when the surgery employed is skillful and under sterile, aseptic conditions.

In the early days of implantation, good teeth were procured comparatively easy. This was before bridge-work came into use and when good teeth were extracted to clear the mouth for suction plates. These teeth are saved now and used as posts or piers on which to fasten appliances. Another means of obtaining good teeth, especially bicuspids, has been very much diminished by the fact that dentists, who used to pull them in order to straighten an arch, now expand the arch to allow the tooth to come into normal position. Fortunately, old teeth can now be used to carry on the work of implantation, for experience has proven that they will revive and attach themselves as well as fresh teeth. The author has rarely had a tooth to plant which has been extracted within six months. Most of these teeth lasted for ten years. The roots of some, however, were absorbed in five years, but it is safe to expect that an implantation, under favorable conditions, will last ten years, with prospects for an indefinite period.

In very old people, in whom the alveolar process and the whole jaw has become absorbed, with the well-known signs of retrograde vitality in the osseous tissues and marrow cells, the operation of implantation appears in-

[1] This patient is mentioned as Mr. L. in a report of 26 cases to the American Dental Association in 1889. Capt. DeM. also mentioned was seen thirteen years later and his tooth was in perfect condition. Mrs. C., who had four bicuspids planted, was seen by a confrére eight years later, who found the teeth in perfect condition. These teeth were all fresh and covered with pericemental membrane.

advisable. In the young and middle-aged, where the resiliency of tissue still exists, the operation is one of undoubted promise. A few operators, having no confidence in the theory of persistent vitality and believing that equal success would follow the implantation of roots formed of gold, platinum, lead and bone, have experimented along this line without success, for the motion established in the sockets in the acts of speaking and mastication produced absorption of the alveolar process and enlargement of the cavity to such a degree that the teeth loosened and eventually dropped out. The encystment of foreign substances, such as bullets, etc., is tolerated and becomes comparatively permanent where the object produces no subjective motion, but the instant that motion is established, mechanical irritation is set up and is bound to cause its expulsion. This is the reason that no mechanical appliance embedded in the jaw and subject to the natural movements of the mouth can ever become a permanent fixture.

In using natural teeth for implantation from one patient to another it is is essential to sound a note of warning to the profession. Syphilis and tuberculosis may easily be transmitted by the implanted teeth. Therefore a thorough test should be made on the donor.

The teeth may be preserved in normal salt solution indefinitely. The tooth should first be immersed in a 1–5000 mercury bichloride solution from one to two hours. It is then transferred with sterile forceps to the sterile normal salt solution.

T. W. B.

CHAPTER XXXIV

CYSTS

Definition and Classification.—A cyst is a sac containing fluid, or a semi-fluid substance, which may be gelatinous or inspissated. In the broadest sense, a cyst may contain mucus, saliva, bile, urine, etc., depending upon the organ with which the cyst is associated. Formerly, cysts were classified under the head of tumors, but the advancement of pathological knowledge has excluded them from that classification. A tumor is a neoplasm, a multiplication of cells; a cyst is a sac or cavity containing a fluid. Cysts, however, may be associated with neoplasms. Pressure made by their presence may, as a local irritant to the surrounding parts, cause multiplication of cells and the consequent development of new growths. Again, cysts may be developed in bone, connective tissue or in any organ of the body by a dilatation from causes sometimes impossible to comprehend.

There are some conditions which seem to be cysts: pseudo-cysts, as diverticula, bursa and neural cysts.

From the standpoint of the oral surgeon, the first group, retention cysts, is the most important as he meets them far more frequently.

A cyst is not necessarily a single cavity or sac. Cysts may be multilocular. The walls are made up of various structures and the fluids differ in composition. Accumulations in the tissues are mainly myxomatous or colloidal, a dropsical or edematous swelling preceding its formation. It may be due to fatty degeneration of the connective tissue. Usually cysts are preceded by inflammatory processes. Fatty degeneration is the result of diminished blood supply, a change in the composition of the blood or a lowering of the vitality of the cells. The fat globules are present in dermoid cysts, sometimes crystallized into cholesterin. Rupture of blood-vessels may be the origin of cysts.

Retention Cysts.—The mouth, jaws and associated parts are frequently the seat of cysts. For practical purposes, we may say that cysts form, first, in the natural cavities of the body and, second, by pressing apart normal tissues where cavities did not exist previously. The simplest form of cyst is to be observed upon the surface of the oral mucous membrane. A minute duct leading from a gland, having been obstructed, dilates under pressure of the accumulating mucus until it becomes greatly distended (Fig. 695). It is to be seen then as a papule or blister. This is a typical muciparous cyst. A retention cyst, therefore, is caused by the obstruction of the free flow of the secretions. On a larger scale, the purest form of a retention cyst

is to be found in the ranula.[1] This is the formation of a cyst of Wharton's duct due to the obstruction of the passage of saliva from the submaxillary gland at the point of exit beneath the tongue.

On the skin we find a simple form of cyst following a contusion or bruise—oftentimes in the hands from rowing or any other manual effort which produces friction and an accumulation of serous fluid beneath the skin. In these cysts we have circumscribed cavities containing fluid, though in a recent contusion there is no well-defined cystic wall. Absorption of the fluid rapidly follows the injury and recovery soon takes place. This is an

Fig. 695.—A mucous retention cyst on the lower lip.

edematous condition. The distinction between it and a typical cyst is that the cyst has a membranous wall, while the contusion or edema is due to the infiltration of serous fluid into the connective tissue.

Cyst Wall.—The lining of a cyst is either epithelium or endothelium, in accordance with the tissues in which it originates. From a clinical point of view, we speak of epithelial cysts, which are due to the distension of ducts or epithelial cavities caused by the obstruction of their orifices by inflammatory processes and, since the fluids within the glands or ducts cannot escape, they are also termed retention cysts. In the mouth we find them associated with the mucous and salivary glands. They may be found in the skin, kidneys, intestines, uterus and mamma. A glandular cyst generally has a well-defined epithelial lining. This lining may undergo fatty degeneration or, by reason of its distention, it may resemble a serous

[1] So called because of the resemblance to the belly of a frog.

membrane. The endothelial cyst may be due to obstructed lymphatics, the sheaths of tendons, or to the distention of cavities in the connective tissues anywhere. They are distinguished from retention cysts by the term *exudation* cysts. In the disintegration of the liver or kidneys resulting from any malady, or in other organs of the body, cystic cavities form and they are known as disintegration cysts (Ziegler).

It is essential to make a distinction between an uncomplicated cyst—a cyst pure and simple, a sac containing a fluid around whose walls a neoplasm has not formed—and one around which a well-defined growth exists. To the latter condition the term cystoma may be well applied since we have not only a cyst, but, associated with its walls, a neoplasm and, according to Senn, this wall is made up of a matrix of misplaced embryonal cells.

According to the location of the cyst and the part with which it is associated, we refer to them as mucous cysts, serous cysts, salivary cysts, blood cysts, fatty cysts, etc. The epithelial or retention cysts contain mucus and saliva. The endothelial or exudation cysts contain lymph, serum, etc. Those in connection with bone have a mixed content.

Other Terms Applied to Cysts.—Cysts are simple and compound; simple if having a single cavity; compound if having numerous cavities communicating with one another. A simple cyst is also known as unilocular; a compound as multilocular.

Pathology of Cysts.—Cysts may vary in size from a most minute papule to enormous proportions.

The membrane forming the wall of a cyst throws out an exudate and, by this means, the cystic contents increase and the pressure upon the surrounding walls causes the absorption of the tissues with which it comes in contact. In the case of a salivary cyst, the physiological accumulation of saliva rapidly swells the cystic cavity and the pressure upon the surrounding parts may cause a raising of the tongue, absorption of the tissues beneath it, distention of the floor of the mouth and of the tissues beneath the angle of the jaw by reason of the dilatation of the submaxillary gland until a marked deformity is visible. The secretion of saliva, however, if the orifice of the duct is obstructed and the passage of saliva into the mouth is no longer possible, takes place more slowly than would be anticipated. Unquestionably, the unaffected salivary gland takes on greater activity and secretes a greater amount of saliva than each would do if all glands were performing their functions naturally and, as a consequence, the dilatation of the duct and the formation of a cyst is rather slow in its development.

The pressure upon the walls of the cyst may not only involve the duct itself, but cause a dilatation of the lobules of the gland, whose substance may undergo disintegration. The tissues of the salivary glands are not infrequently filled with calcareous deposits, the epithelial membrane it-

self disintegrating by reason of pressure and irritation. The contents of the cysts, therefore, will be stained with blood, giving to the exudate a dark brown appearance. On the other hand, the irritation may produce hypertrophy of the membranes until they have become so thickened and unyielding that the pressure of the continually increasing fluid may cause severe pain.

Cystic walls may break down from fatty degeneration, or they may, by reason of infection, undergo disintegration. When calcareous forma-

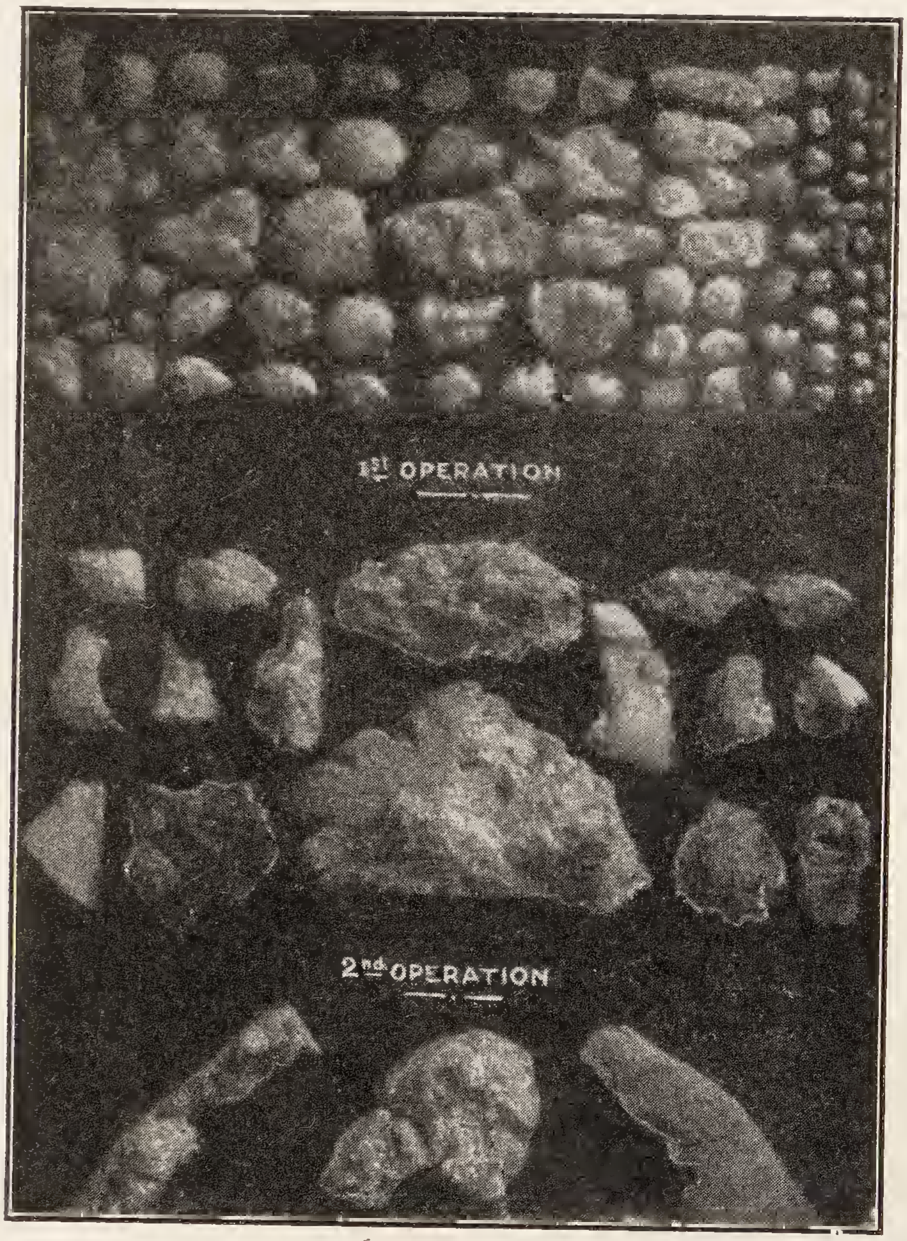


Fig. 696.—A series of over 100 small denticles removed from the lower jaw at three different operations. (*J. Ward Cousins.*)

tions take place in the substance of the glandular tissue, general disintegration of the gland usually will ensue. It is by reason of this irritation of the membranous walls of the cyst that neoplasms are induced. The consideration of these morbid changes will be taken up under treatment of cysts.

The contents of a cyst change with its age. In a mucous cyst we find, when opened, that the mucus is thick and honey-like. In a salivary cyst, or ranula, the contents, instead of being like colorless saliva, are oftentimes amber colored, sometimes brown. When of long standing, the contents escaping are tenacious and ropy.

Dentigerous Cysts.—A dentigerous cyst has for its nucleus a tooth or teeth. It may develop around masses of tissue composed of tooth structure, some of which resemble normal teeth while others, called denticles, are irregular in size and form. The nucleus may be a single tooth or denticle, or the cyst may contain many teeth or denticles (Fig. 696). Normal permanent teeth are most frequently involved in these cysts (Fig. 697), but imperfectly formed teeth, supernumerary teeth (Figs. 698 to 700) and denticles, many of which are shapeless, are often the center of irritation about which the cyst

Fig. 697.—Retained second premolar tooth surrounded by a dentigerous cyst. The upper wall of the cyst and fluid contents were removed leaving the tooth in place. (*Cryer.*)

forms. Deciduous teeth (Fig. 701) are seldom associated with dentigerous cysts. Only twelve such cases have come under the author's observation. They are located in the cancellated structure of the body of the bone.

Normally, the teeth emerge from their bony crypts and take their places in proper alignment in the dental arch. If impossible to erupt, from any cause, these aberrant teeth remain imbedded in the bone and the irritation caused by their pressure upon the tissues, in nature's efforts to erupt them, is often followed by an accumulation of fluid, varying in quantity according to

the size of the cyst. An incipient dentigerous cyst might be quickly and easily cured by relieving the pressure of the erupting tooth. Non-erupted, impacted teeth, however, may remain in the bone through life without causing the slightest inconvenience.

The maxillæ are more frequently the seat of dentigerous cysts than the mandible. In order of frequency, molars are first involved, followed by

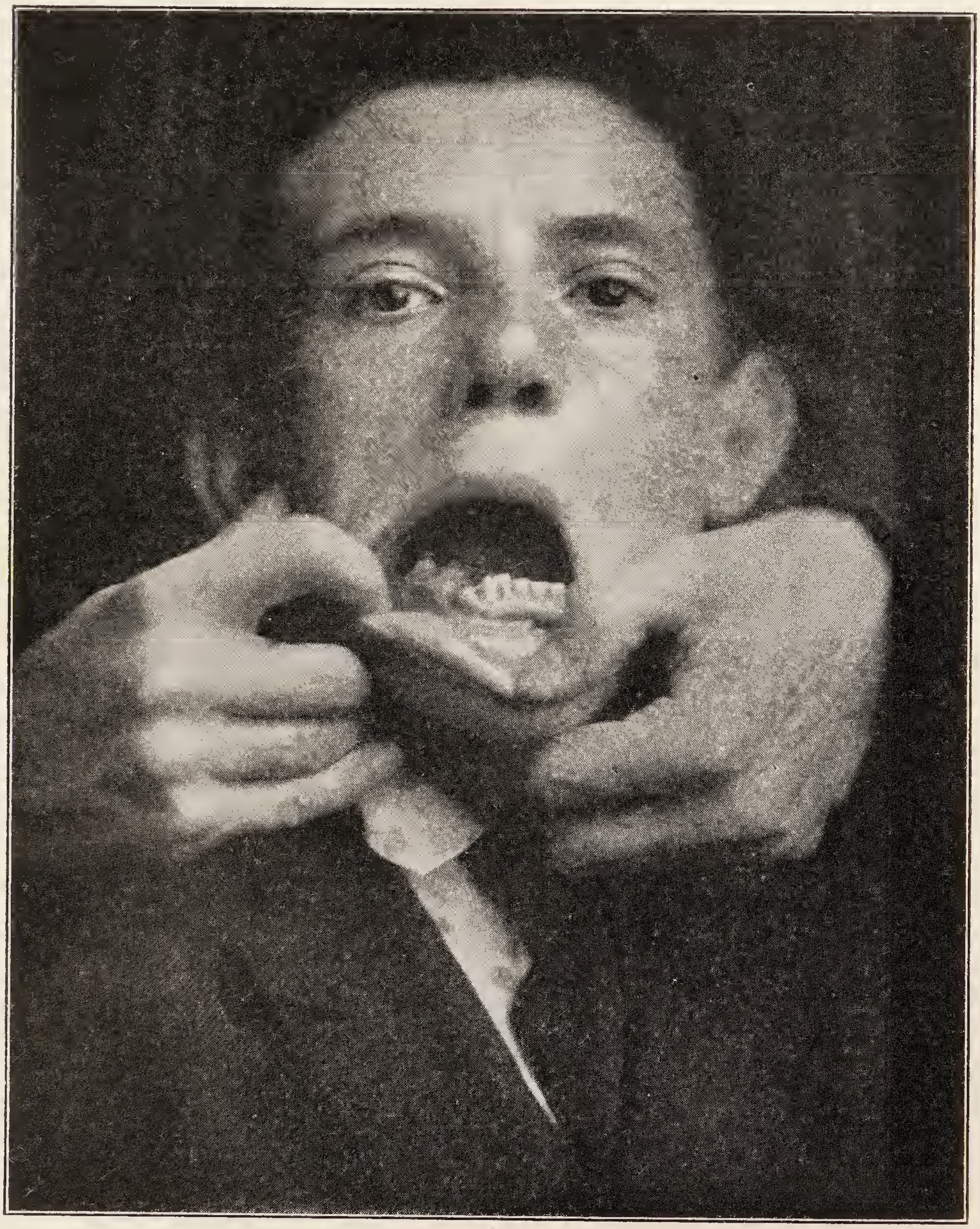


FIG. 698.—A dentigerous cyst in which a bicuspid tooth forms the nucleus. In this case there were three bicuspid teeth on the right side of the mandible. Patient was fourteen years old. Before operation.

cuspids and bicuspids. Any tooth, however, may be the nucleus of a dentigerous cyst. The epithelium which dips deeply into the submucous tissue to form the tooth enamel, the dental follicle, becomes the cystic wall or membrane. Recognizing this fact, Bland-Sutton designates them "follicular odontomes." The wall varies in thickness and is an expanded tooth-follicle.

The contents of the cyst, besides the tooth, teeth or denticles, is a viscid, stringy fluid often containing cholesterin. Dentigerous cysts sometimes attain enormous size (Fig. 705).

Cysts of the jaws which result from chronic abscesses are not dentigerous cysts. Such cysts have a periosteal wall. Like dentigerous cysts, they increase in size, the surrounding bone is absorbed, the surfaces often become

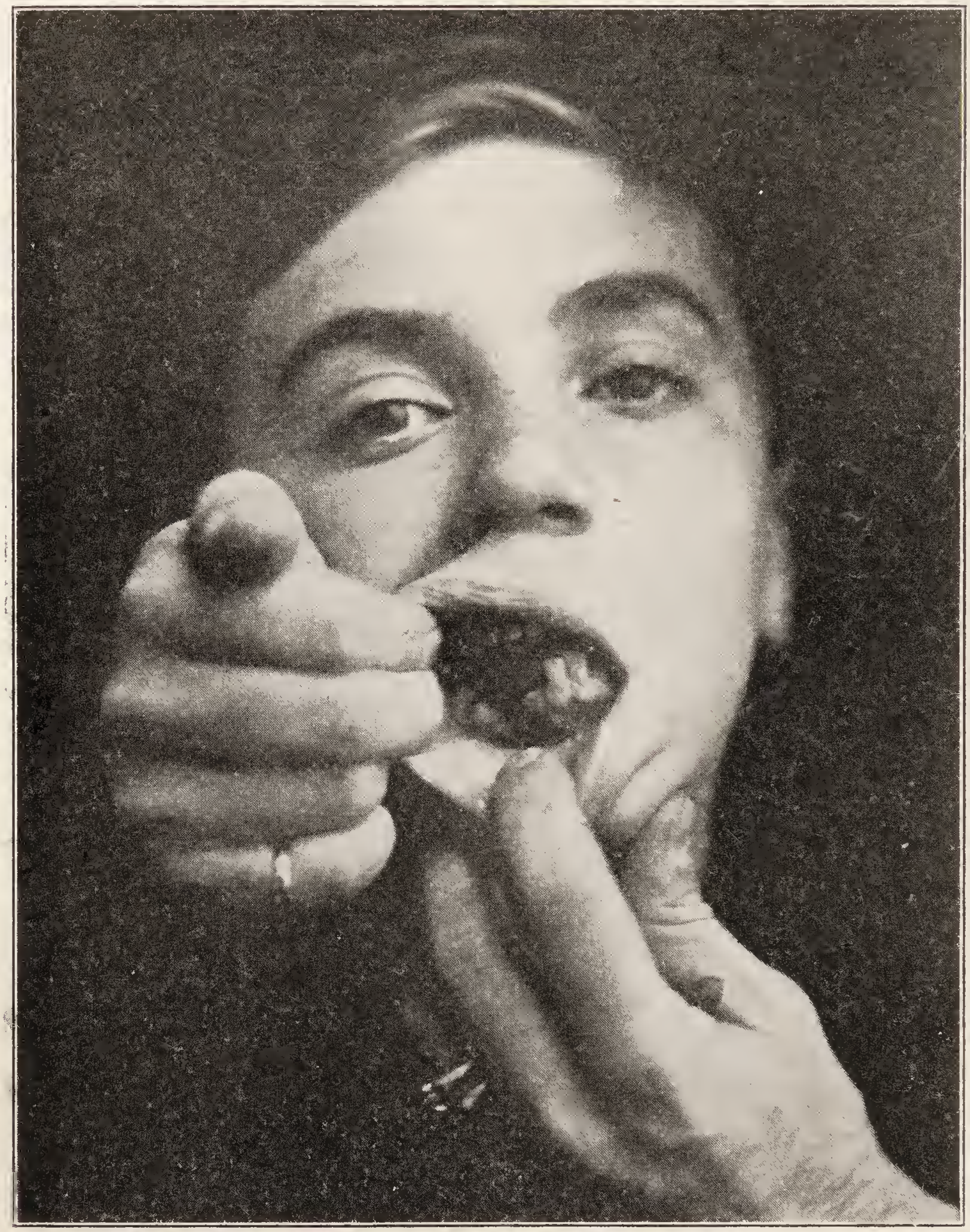


Fig. 699.—After operation.

thin and crackle on digital manipulation. Extensive loss of bone by absorption may take place in a dentigerous cyst, due to the pressure of the fluid (Figs. 706 and 707). Dentigerous cysts seldom cause pain. Any pain attending them is due to pressure upon adjacent nerves. I have seen a patient whose entire left maxilla, save only the alveolar, malar and nasal processes, was destroyed by a dentigerous cyst, who asserted she never had pain from

the condition. The varying degrees of deformity are illustrated in Figs. 708 to 710. Except in extreme cases there is little redness over the cyst.

Dentigerous cysts seldom contain pus. Dentigerous cysts may occur at any age, but more frequently in youth, rarely appearing after the thirtieth year. They are slow in developing.

Diagnosis.—Absence of any of the permanent teeth suggests that the absent tooth may be the cause of the cyst. The absent tooth, however, may have been extracted. Patients' statements regarding the extraction of teeth are not always reliable, as they may forget.

FIG. 700.—*X*-ray showing the destruction of bone and third bicuspid tooth.

On digital manipulation in advanced cysts, crepitation of the thin, bony wall will be noted. Small lamina of bone, left by absorption of the intervening thin portions, like islands of ice upon the water in the springtime, come in contact on pressure, producing the characteristic crackling sound. Palpation reveals the presence of the fluid which may be withdrawn by an exploring needle and examined. It is very important to use the exploring needle to determine the character of the fluid, as a cyst may simulate an abscess or an aneurism. Calcareous deposits are occasionally found in the

cyst. The advent of Röntgen photography placed at our command the most reliable means of making a positive, accurate diagnosis. The illustrations, Figs. 700, 701 and 711 clearly outline the cause of the cyst and the location of the disturbing element. Tumors of all kinds and empyema of the antrum should be excluded. Transillumination and good Röntgen photographs will determine the diagnosis.

FIG. 701.—Retained deciduous second premolar tooth at bottom of the jaw in nine-year-old child. There was a swelling on the lower jaw for over two years. (*Cryer.*)

Treatment.—The treatment of a dentigerous cyst consists in opening it intra-orally, removing its contents, including a tooth or teeth, together with the investing membrane. It is essential to remove every portion of the membrane surrounding the cyst in order to avoid a recurrence.

When the bone is thin and parchment-like, it may, by compression, be returned to its normal position and the external deformity removed. If,

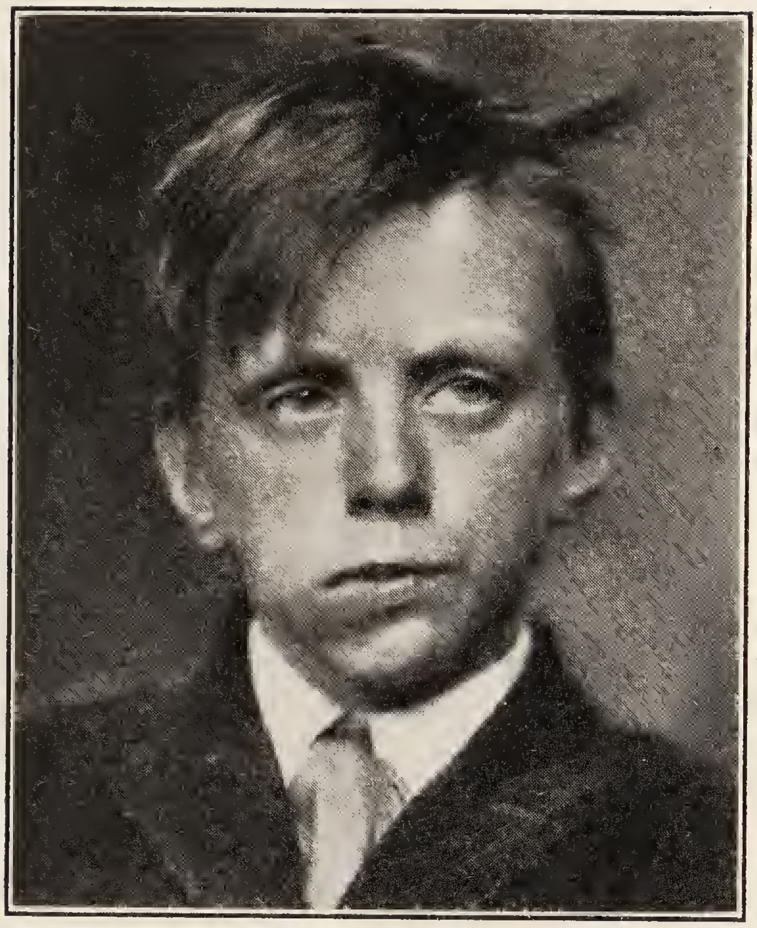


Fig. 702.—Boy, nine years of age, with a dentigerous cyst of the mandible involving the central and lateral incisors, cuspid and both bicuspid teeth. The cyst was accompanied by an extensive fibrous growth. The teeth were completely concealed from view by the growth. The upper teeth made deep impression in the growth. The cyst and tumor were removed intra-orally. Three months have elapsed with no recurrence.

Fig. 703.—Oral view of the same cyst.

Fig. 704.—Skiagraph of the same patient.

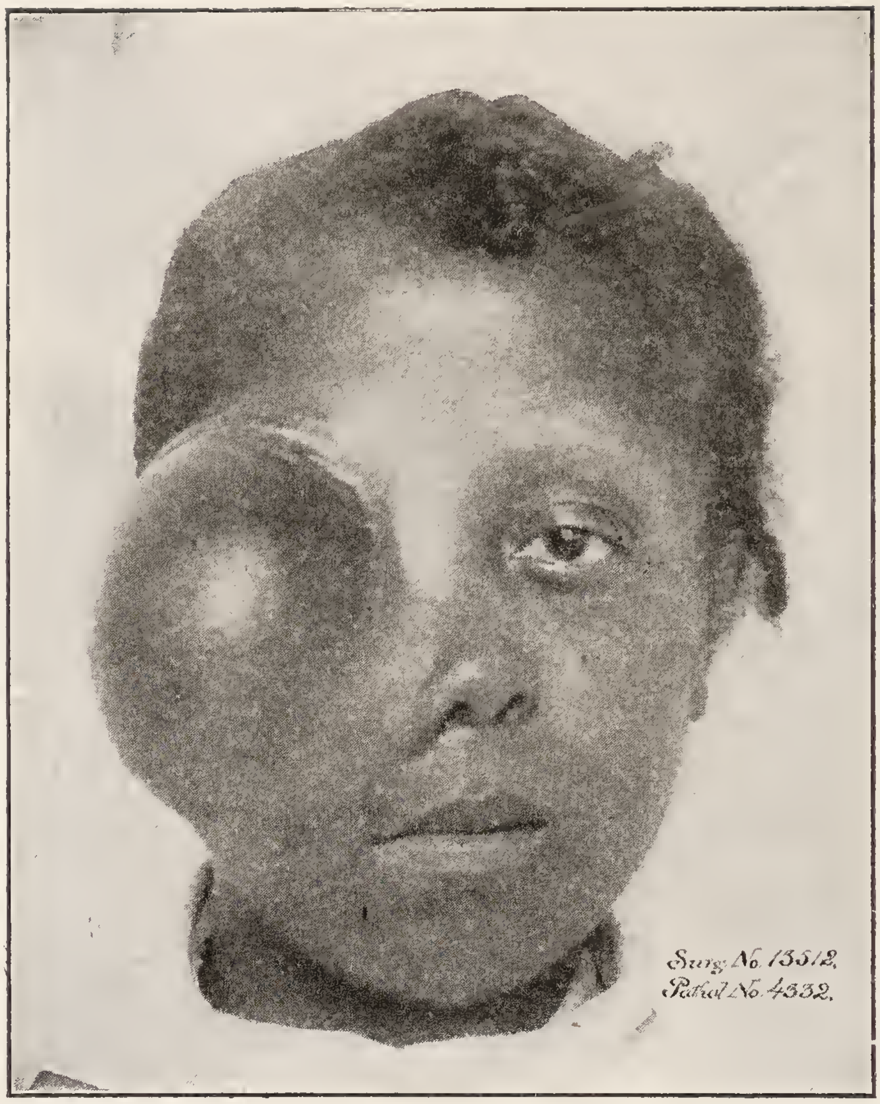


FIG. 705.—Dentigerous cyst of upper jaw. Colored girl, aged nineteen; swelling thirteen years; parchment crepitation; teeth normal. Complete excision of upper jaw on diagnosis of sarcoma. Death from pulmonary abscess. (*Johns Hopkins Hospital. American Practice of Surgery.*)

FIG. 706.—Dentigerous cyst of the mandible. (*Royal College of Surgeons.*)

however, the bone is thick and unyielding, it may be necessary to excise or break it and carry it back to its normal position.

FIG. 707.—Same cyst showing the inclusion of a tooth.

It is necessary, however, to maintain an opening so as to promote the formation of granulations within the cystic cavity with a view to filling it up. The opening should be packed with iodoform gauze which should be changed

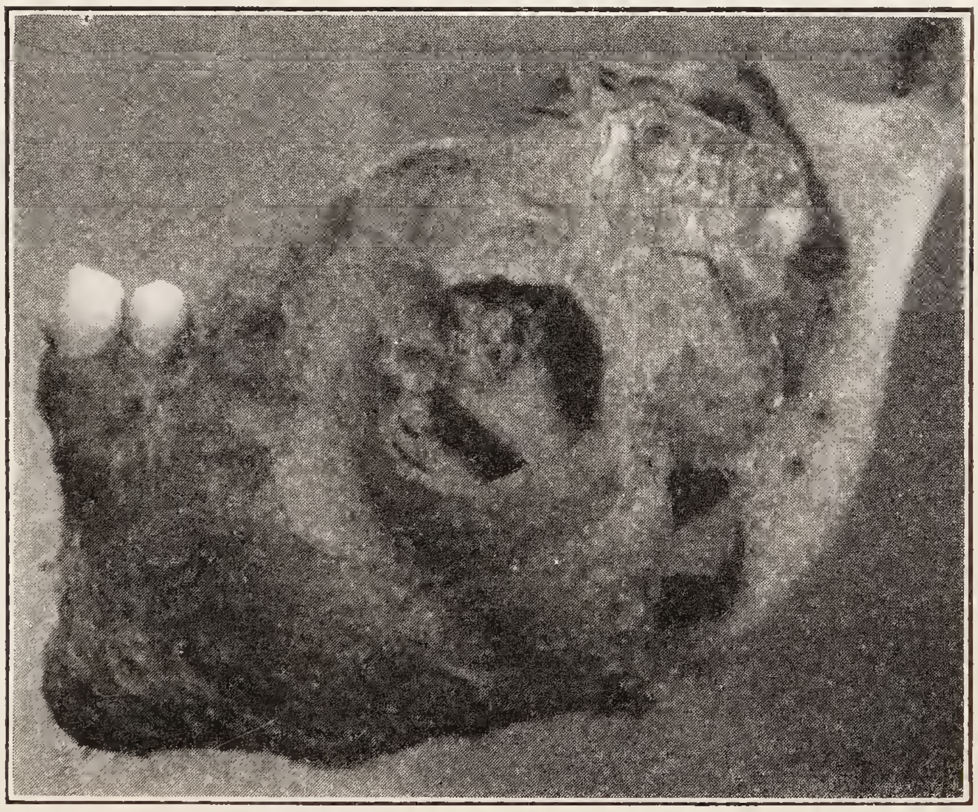


FIG. 708.—Dentigerous cyst of the mandible showing the extensive expansion of the external plates. (*Bloodgood.*)

and the cavity irrigated every forty-eight hours for a week. After this the gauze should be removed, the cavity irrigated, and a gutta-percha plug made to maintain a large opening. The plug is easily removed two or three

times a day for the irrigation of the cavity, thus keeping it free of irritating secretions. If the wound is permitted to close before the cavity fills with granulations, recurrence of the cyst is almost certain to follow.

The walls of the cavity may be scarified from time to time so as to promote the formation of granulations more rapidly. The plug should be made use of as long as may be necessary to retain the opening and until granulations have filled the cavity. The plug may then be reduced in size a little from time to time, by paring it down, as the cavity fills.

The most serious sequel of a dentigerous cyst is the absorption of the bone against which the cyst exerts pressure. As previously stated, the entire

Fig. 709.—After operation.

Fig. 710.—Dentigerous cyst on left side of the face, showing a large swelling. Before operation.

maxilla, even the nasal septum, may be destroyed by contact pressure and absorption. In the development of a dentigerous cyst in the mandible the deformity resulting in extreme cases may be irreparable. The entire body of the bone, from the cuspid tooth to the angle, may be absorbed in the invasion of the cyst. A retraction of the mandible, with a loss of occlusion of the teeth on the opposite side, as in the case of a compound fracture, will result. In the absence of any bone, a prosthesis is essential. In such cases the osteogenetic powers of the periosteum may develop new bone and the deformity may in part be overcome.

Hydrops Antra.—From the point of view of the oral surgeon, cysts within the accessory sinuses to the mouth and those of the glands associated therewith are of the deepest interest. Cysts of the antrum of Highmore may result from the occlusion of the normal opening through the antro-nasal

wall (the osteum maxillare). The retention of the mucus and the filling of the antrum may be followed by absorption of its bony walls and the development of a typical cyst.

A cyst forming in the antrum, or developing from the antral mucous membrane, is technically known as Hydrops Antra, or dropsy of the antrum (Fig. 713).[1] In Hydrops Antra the mucosa usually undergoes cystic degen-

Fig. 711.—A mandibular cyst which originated at the end of a tooth root. There was extensive absorption of the mandible.

eration. The fluid collects to the extent of filling the cavity and then the antral walls suffer by reason of pressure and absorption. The fluid, as in other cysts, varies in color and consistency. It may be amber colored, brown, albumen-like, gelatinous or honey-like, and sometimes contains a great quantity of cholesterin. The accumulation of this fluid does not cause pain. With the increase of its contents the walls of the antrum must yield.

This fluid is the result of irritation which may have been communicated to the antrum through the medium of the nasal cavity by the continuity of

[1] See Empyema of Antrum.

the mucous membrane of the nose with the antrum or by occlusion of the natural opening by which the fluid's exit is cut off. The membrane is then continually irritated by the presence of the fluid and increases its exudate

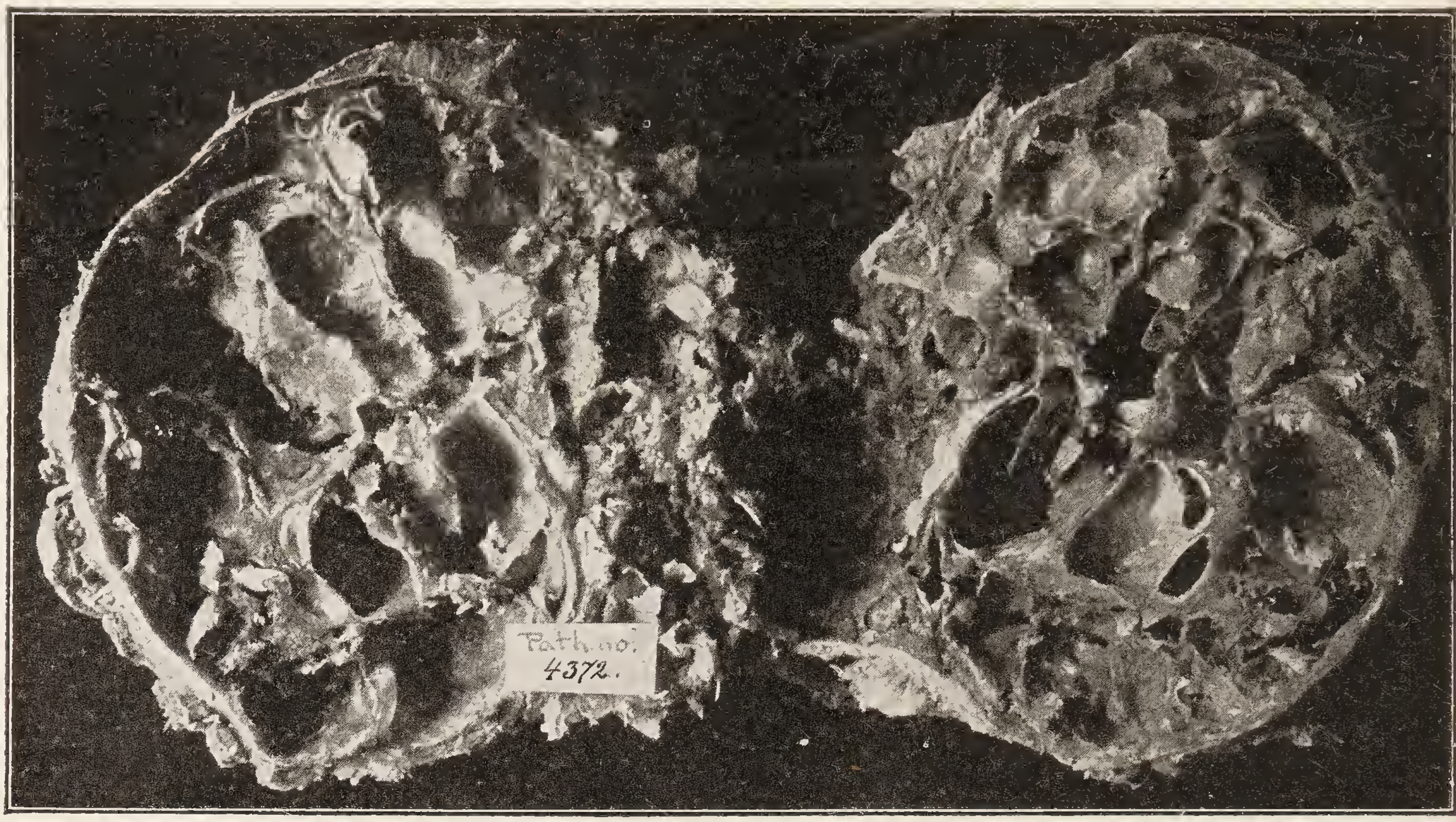


FIG. 712.—Multilocular, dentigerous cyst of upper jaw. White girl aged eight years; duration of tumor not known. Complete excision of jaw on diagnosis of sarcoma. Death from shock. (*Bloodgood, Johns Hopkins Hospital Collection in American Practice of Surgery.*)

until the antrum is filled. Another method of causing an irritation is from the roots of diseased teeth.

Hydrops Antra, after the antrum is filled, runs the usual course of absorbing the bony walls until the point which affords the least resistance

FIG. 713.—A cyst of the antrum.

finally yields and the fluid is discharged through a rupture or sinus. The wall which affords the least resistance may be the anterior, through the canine fossa, the posterior, the nasal or the orbital wall. Should the fluid escape

Fig. 714.
Ranula. (*Butlin in Spencer and Gask.*)

through the nasal wall, the enlargement will subside somewhat and the patient feel that the malady has terminated. The parts have not, however, permanently recovered their normal condition and recurrence is almost certain.

Symptoms of Hydrops Antra.—The absence of pain characterizes the development of cyst of the antrum. Distention of its walls and the prominence beneath the eye and under the malar bone is due to the absorption of the anterior antral wall. Digital manipulation within the mouth and over the distended tissues is marked by fluctuation and parchment-like crepitation. The crackling beneath the fingers is caused by the movement of the thin fragments of bone over each other, since the absorption has left thin lamina of the bone over the surface of the fluid.

The nose may be forced to the opposite side and its fossa occluded by the distention of the naso-antral wall. The eye may be lifted upward, with protrusion forward. Sometimes the hard palate and alveolar processes are absorbed, forcing the mucous membrane downward, loosening the teeth from the partial absorption of their alveoli and causing a prominence upon the surface of the palate, a condition in striking contrast with empyema of the antrum, as shown by the following table:

Empyema of Antrum	*Hydrops Antra*
History of pain.	No pain.
Rising temperature.	No temperature.
Walls of cavity rarely absorbed.	Walls of cavity absorbed.
Discharge from nose.	No discharge from nose.
Marked opacity by trans-illumination.	Little or no opacity by trans-illumination.

Prognosis of Hydrops Antra.—The prognosis of Hydrops Antra is favorable if the treatment employed has been thorough. Drainage affords only temporary relief. Following drainage and irrigation only, the cyst will recur. The protrusion of the cheek or eye will be overcome after the evacuation of the fluid.

Treatment.—The treatment of cysts of the antrum is to make a liberal opening through the canine fossa, evacuate the fluid, thoroughly curette the cavity, remove the cystic membrane in all of its parts, pack for forty-eight hours, further irrigate, and keep the cavity open until the walls of the antrum have become healthy, after which the opening may be permitted to heal (Fig. 228).

Mucous Cysts.—Cysts forming upon the mucous membrane of the mouth may be successfully treated by evacuating their contents and cauterizing the walls. One application of tincture of iodin, oil of cassia, zinc chloride fifteen per cent., or phenol ninety-five per cent., followed by alcohol, will usually be sufficient to effect a cure.

Ranula.—A ranula is a cyst of the salivary glands, or Wharton's or Rivini's ducts (Fig. 714).

Cysts of the Duct of Steno or of the parotid glands may occur from pressure and irritation of their orifices and they are sometimes the initial lesion of malignant growths. They occur less frequently than cysts in Wharton's and Rivini's ducts. A ranula is a bluish-white, semi-translucent swelling and is so called from its resemblance to the belly of a frog. It is due to the retention of the saliva in the ducts of the sublingual and submaxillary glands. It may be caused by the deposit of salivary calculus within the duct (Figs. 715 and 716) or from an irritation of the orifices of the ducts, followed by adhesions which prevent the exit of saliva into the mouth. It may be caused by trauma.

Ranulæ present the most typical examples of retention cysts. They are usually unilateral, occupying one side of the floor of the mouth and lifting up the tongue. They may increase to an enormous size and interfere

FIG. 715.—Calculus in Wharton's duct.

FIG. 716.—Photograph of calculus removed from Wharton's duct in cases shown in x-ray.

with speech. They are not painful except as they make pressure upon the nerves of the surrounding parts. The contents vary in color and consistency according to age. On evacuation, the fluid is found to be ropy, albuminous in appearance, sometimes discolored, varying from clear to dark brown, due, probably, to the extravasation of blood from its walls.

A ranula may be congenital or acquired. It may be simple or complicated. It appears in the following forms:

1. Sublingual ranula.
2. Submaxillary ranula.
3. Blandon's ranula.
4. Incisive ranula.
5. Complicated ranula.

Sublingual Ranula.—This is due to the obstruction of the Rivinian or sublingual duct and a dilatation of the acini. The papillæ are usually very greatly distended and the tongue elevated on the side of the mouth involved. The irritation of the orifice of the duct is not infrequently due to the accumulation of salivary calculus upon the lingual surface of the lower in-

cisor teeth. This incrustation extends backward beneath the tongue and, coming in contact with the papillæ, produces irritation followed by adhesions and closure of the duct. The retention of calculus within the ducts themselves may obstruct the flow of saliva within the mouth and thus become the cause of ranula.

Submaxillary Ranula.—This form of ranula originates from obstruction and dilation of the duct of Wharton. The obstruction, as in the case of the Rivinian duct, may be due to retained salivary calculus, adhesions following inflammatory processes of any character or from trauma. The distention of the cyst, in case of submaxillary ranula, is not so near the anterior portion of the floor of the mouth as we find it in sublingual ranula. The distention may extend back so as to involve the submaxillary gland itself. When beneath the angle of the jaw, it is oftentimes very conspicuous. The fluid contained in this cyst is not unlike that previously described in sublingual ranula—thick and glairy, varying in color according to age and the condition of the cystic walls.

Blandon's Ranula.—This consists of an obstruction of Blandon's ducts, which lie at either side of the median line beneath the tip of the tongue. Protrusion of the tongue will usually carry the ranula forward.

Incisive Ranula.—An incisive ranula is a dilation of a small racemose gland which lies at the side and beneath the frænum of the tongue, or the lingual surface of the mandible, and opens just posterior to the lower central incisor teeth. We find its contents to be glairy and albuminous-like in appearance, similar to the others.

Complicated Ranulæ.—Ranulæ are frequently associated with neoplasm (Fig. 717). Pressure or irritation established by the retention of the saliva may become the exciting cause of proliferation of cells. It is important, therefore, in making the diagnosis, to endeavor to ascertain the condition of the tissues immediately surrounding the cyst. In the submaxillary, new growths occur in connection with ranulæ, though growths of the submaxillary and sublingual glands are not as common as those involving the parotid. A ranula may be complicated by an infection as the mouth is the seat of many pathogenic bacteria.

Diagnosis.—The description of the forms of ranula outlines quite clearly the conditions as they are met. The history of the case, the length of time since the patient first observed the parts distended, the question as to whether a new growth has developed in connection with it, the cause of the obstruction of the duct, and the means of investigating and exploring, consisting of digital manipulation of the parts and the employment of skiagraphy, will guide the surgeon in making his diagnosis. In making a skiagraph, it is necessary to so pose the patient that the mandible and teeth cannot obstruct the rays of light which are carried through the soft parts forming the floor of the mouth. If pencil-like deposits of calcific matter have formed within the ducts or, possibly, in the glands themselves, they

will frequently be clearly outlined in the plate. Their presence calls for measures to remove them. Ranula must also be differentiated from dermoid cysts and lymphangioma.

Treatment.—The treatment usually employed for the evacuation of a ranula has, in the hands of all surgeons, been more or less disappointing.

Fig. 717.—Ranula complicated by fibroma. Both removed intra-orally.

A seton is generally made use of, passed through the cyst and allowed to remain for the purpose of evacuating the fluid. As in the making of other minor operations, a local anesthetic may be used in puncturing the walls of the cyst for the introduction of the seton. Another method is to cut away a little elliptical-shaped piece of the wall, thus allowing the fluid to

escape. The entire cystic wall may be dissected out, especially in complicated cases in which growths are developed along with the cyst.

Silver Ring.—The best course to pursue is to puncture the cystic wall in two places, making use of a silver tube about 3 mm. in size, curved so as to form a ring about one-half inch in diameter. This ring is then perforated with many holes throughout its entire circumference. One end is carried into one of the openings made and out of the other. The ends of the tube telescope each other and form a ring (Fig. 718). This ring is allowed to remain several weeks. The openings within it admit the saliva

Fig. 718.—Simple ranula showing circular perforated tube in place.

from the interior of the cyst and the saliva passes outward, making its exit through the openings in the ring outside of the cyst. This little ring is of no special discomfort to the patient. Its presence is observed, but it is easily tolerated. It not only admits of the exit of saliva, but it is smooth upon its outer surface and the freshened tissues about it will soon become smooth and healed over with new membrane. Thus we establish a permanent orifice through which the saliva may escape.

The tube should be rotated daily so as to prevent granulations from entering the small openings and either obstructing the tube or preventing the surface of the membrane from becoming thoroughly healed over and smooth.

Patients thus treated, in cases of uncomplicated cysts, rarely have a recurrence, whereas puncturing the cyst and introducing a seton or evacuating it from time to time with the knife is always a temporary expedient as the closing of the wound almost invariably leads to a recurrence of the cyst.

Having made use of this means of treating ranula for many years, I am certain the cures are most permanent.

Dermoid Cysts.—Dermoid cysts are developed by the infolding of the epiblast or hypoblast and are surrounded by connective tissue. Thus, buried in the tissues, they are capable of producing dermal appendages, such as hair, nails and teeth. Dermoid cysts are most frequently found in the

Fig. 719.—A dermoid cyst of the ovary containing teeth and hair. (*Dr. R. W. Bunting.*)

generative organs, usually the ovaries. They may be found in the peritoneum, sternum, neck, cheek, mouth, about the orbit, in the median line of the palate, in fact, at any point where the skin closes in embryonal life.

Dermoid cysts are congenital. The late Prof. William H. Byford removed an ovarian cyst in which there were four hundred teeth, varying in size and containing all the different forms. Some were perfect incisors, cuspids, bicuspids and molars, while many were irregular, not resembling in form any tooth. Some were cubiform, others were sharply curved and many were small clumps of irregular forms. Marshall speaks of a dermoid cyst of a horse, located in the temporal region, which was removed by Professor Sayer of the Chicago Veterinary College. This cyst had been discharging for several months and, when opened, was found to contain a well-developed incisor tooth.

By the kindness of Dr. Bunting of Ann Arbor I present Fig. 719, a der-

moid cyst of the ovary. Prof. Arthur Keith has furnished me with Fig. 720, dermoid cyst of the ovary, and Fig. 721, cyst of the testicle.

Dermoid cysts, though congenital, may not manifest themselves until middle or advanced life. They are slow of growth and painless except as they interfere by pressure with the surrounding nerves. They are accidents in development.

Fig. 720.—A dermoid cyst of the ovary, containing two irregular pieces of bone both of which bear many teeth. Some are incisors, others canines, bicuspids or molars, and in one case two teeth appear to be fused. (*Doran, Royal Coll. Sur.*)

Symptoms and Diagnosis of Dermoid Cysts.—There is little to be noted in the symptoms of a dermoid cyst. Very rarely is pain experienced. The first sign, usually, is a slight enlargement in the area affected. This continues gradually until, at the end of a term varying from a few months to several years, the enlargement attains a size sufficient to cause some inconvenience. At that time it may become painful from the irritation of the clothes, etc.

Rarely is the diagnosis difficult because of its location. It is always found close to the lines of skin closure in embryonal life. The skin over the tumor is freely movable and non-inflamed. The base of a dermoid is always attached deeply to the underlying structures. The sebaceous cyst sometimes

causes great difficulty in making a diagnosis. The common location of both on the skin of the face and neck renders the diagnosis essential. The sebaceous cyst is always attached to the skin and is usually freely movable over the deeper structures. Lipoma and lymphangioma occasionally enter into the differential diagnosis.

Treatment of Dermoid Cysts.—The treatment of dermoid cysts calls not only for complete removal of the cystic fluid, but of the cystic

FIG. 721.—Dermoid cyst occurring in the testicle of a boy. Projecting into the cyst is an irregularly lobulated process from one pole of which protrudes the crown of a multicuspidate tooth. Hairs were also found in this growth. This growth was congenital. (*Dr. Booth, R. C. S.*)

walls. This must be accomplished thoroughly as the retention of a particle of the wall, though almost unobservable, may become the nucleus of a recurring cyst. It is frequently necessary to follow the cyst down to its attachment to the bone.

Sudoriparous Cysts.—Sudoriparous cysts are due to the occlusion of the orifice of the duct of the sweat glands. They are not of frequent occurrence. The fluid collects and distends the parts, but with little or no pain. These cysts may form upon the face and, while painless, they are a great disfigure-

ment to the patient. The cysts should be opened and the walls either nucleated or destroyed. The application of tincture of iodin, promotes granulations and will, as a rule, permanently prevent their recurrence.

Sebaceous Cysts or Wens.—As in the development of other cysts, these are due to the occlusion of the natural outlet of the gland. The fluid gradually gathers and the walls of the duct are distended, thus forming the cyst. They develop slowly and in size vary from a minute enlargement to a growth measuring from 5 to 10 cm. in diameter. They are usually located upon the scalp over the parietal bones, but occasionally may be found over the occipital, temporal or frontal bones. They may be single or multiple. When appearing upon the scalp, the hair follicles, which cover the cyst, are destroyed. The cyst appears as a smooth, glistening enlargement. The color depends upon the pressure of the contents. It may be reddened somewhat or it may be paler than the surrounding skin, but it is always smooth and shiny. It is seen most frequently in men and usually appears about middle life.

The contents of the cysts vary according to age, but usually appear as a thick, semi-liquid material, a pulpy mass composed of fat and epithelial débris representing the broken-down cells of the Malpighian layer. They sometimes contain undeveloped hair and crystals of cholesterin. Occasionally the contents are solid or semi-solid, a cheesy-like mass. The contents or the inner layer of the walls may become dry and horn-like; in rare cases they may be calcified.

Sebaceous cysts are the sequel, usually, of injuries to the surface of the skin. A contusion may result in inflammation, which may be followed by the closure of the orifice of the duct. If irritated by friction, blows or falls, they may undergo ulcerative degeneration and, if subject to continuous irritation, they may degenerate to malignancy.

The treatment consists in evacuation of the cyst and thorough enucleation of its walls. An omission to remove the entire wall may be followed by recurrence of the cyst.

Comedo.—Comedo is the condition of the skin commonly known as "black-head." It is due to the retention of the secretions of the sebaceous glands, which are retained in the excretory ducts. They appear on the surface of the skin as little brown or black points. These cysts sometimes contain minute hairs. Pressure applied to them expels the sebum. This mass, with the brown head, is popularly termed a "worm." They are located generally upon the chin, cheeks, forehead, and occur most frequently at about the age of puberty.

In view of the fact that the surface of the skin retains these secretions, it would seem that the disease might be the result of a lack of cleanliness, but its history points out conclusively that men engaged in handling coal, sweeping chimneys and stoking furnaces, though continually covered with coal smoke and dirt, are usually free from this disease, while young people

holding the most prominent social positions, with all facilities for bathing and following the laws of hygiene, are not infrequently subject to it.

Treatment of Comedo.—Patients have been found to suffer from indigestion and constipation, therefore, the general condition should be given attention. Local treatment is, by no means, all that is required to relieve a patient from comedo. Diet, bathing, exercise—all that enters into the establishment of good circulation, digestion and assimilation—must be considered and properly dealt with.

The face should be bathed with hot water and the surface dried, after which an application of resorcin ointment, or the following prescription of Professor Hyde may be used:

Sulphur Precipitate
Alcohol
Tincture Lavender Compound
Glycerol
Aqua Camphor
One ounce of each. Mix and apply.

Milium.—The condition recognized as milium or grutum consists of yellowish elevations of the skin and is to be considered and treated in the same manner as comedo.

Multilocular Cysts of the Mandible and the Maxillæ.—A multilocular cyst is one containing many cavities—an accumulation of small cysts (Fig. 722). Magitot's classification of cysts of the jaws into periosteal or peridontal and follicular cysts simplifies the presentation of the subject of cysts of this character. According to Senn, bone cysts result from "embryonic inclusion of a matrix of epithelial cells." They involve the jaw bones, the mandible more frequently than the maxillæ. While authors differ as to the origin of multilocular cysts, all will agree that their development is dependent on irritation and infiltration of fluid into the cancellated bony tissue. Multilocular cysts of the jaw are also called epithelial odontomes (Sutton).

Etiology of Multilocular Cysts.—Multilocular cysts of the jaw bones are usually the result of prolonged inflammation which originates in diseased teeth or roots of teeth. They may be due to trauma or to any condition of the parts which establishes and prolongs inflammation. In the researches of Senn, he came to the conclusion that they have origin from a matrix of embryonic epithelial cells and that misplaced dental germs are not the cause of the abnormality, since the mandible is more frequently the seat of the cyst. It must be borne in mind that the mandible is more exposed to injury than the maxillæ and this would be an explanation of the more frequent occurrence of cysts in the mandible. Sutton describes multilocular cysts as epithelial odontomes and says that they originate from the epithelium of the tooth enamel-organs.

Marshall states "The origin of supernumerary teeth and small, malformed teeth or denticles often found in the dentigerous cysts may also be

explained in the same manner. These persistent portions of the epithelium of the enamel-organ are derived from the epithelial cord of the tooth-germ, which has been cut off from the enamel-organ by the closing of the dental follicle. After the cord has been separated from the enamel-organ by this process, it breaks up into minute globules (Magitot) which are absorbed, but if for any reason they are not removed by absorption, these globules may develop into supernumerary teeth or denticles, or they may induce the formation of multilocular cysts, the 'epithelial odontomes' of Sutton.

Audry is of the opinion that multiocular cysts have a positive connection with the enamel-organs. He also succeeded in demonstrating the epithelial origin of these growths. Their origin, therefore, would invest them with a certain degree of malignancy. These observations most positively confirm the first researches of Falkson and Melassez as to the origin of many of the maxillary tumors.

Kruse also confirms these investigations and considers the origin of these cysts to be the paradental débris of Mellassez.

Multilocular cysts are sometimes termed *proliferating follicular cystomata* from the nature and character of their development, which is generally thought to be due to the gland-like arrangement of the 'tumor matrix' and the proliferation of the epithelial cells. The cancellated structure of the bone may favor the multiple character and growth of this variety of cyst by the rupture or absorption of the thin septi or partition walls which exist between the vacuoles or loculi as the cysts grow and the fluid increases in quantity.

The recent anatomical researches of Cryer upon the mandible also favor the supposition that the multilocular character of these cysts may be influenced by the peculiarities of the structure in which they are formed. Cryer has demonstrated the inferior dental canal to be a cribriform structure; that an abundant communication exists between the vacuoles or loculi of the cancellated tissue of the bone; that the alveoli of the teeth are not only in communication with the inferior dental canal, but with the loculi of the cancellated tissue in all directions and with one another through the same channels, thus furnishing, in the opinion of the writer, a possible explanation of the multilocular character of those cysts of the lower jaw which appear to be induced by the irritation of diseased teeth and trauma.

If, therefore, this supposition is correct, a single cyst of epithelial origin, located in any portion of the alveolar process, the ramus, or body of the bone, might readily become multiple by the growth following the communicating canals and occupying the loculi of the cancellated tissue in its immediate neighborhood, expansion of the loculi taking place as the fluid accumulated.

Inflammation alone, according to Senn, is never productive of tumor formations—neoplasms—but that inflammation occurring in the immediate neighborhood of a tumor matrix, whether of prenatal or post-natal origin, causes an increase or augmentation of its blood-supply, which arouses the

embryonic tissue from its dormant condition and stimulates it to active cell proliferation.

Multilocular cysts of the jaws, according to the best authorities upon this subject, may be stated to be caused by the presence within the jaws of embryonic 'inclusions' or 'nests' of epithelial tissue—probably derived from the epithelial cords of the enamel-organs during the development of the teeth—which have been stimulated to active cell proliferation by injuries to the jaws, inducing an increase in their blood-supply through inflammatory conditions."

While theories have been advanced as to the origin of the epithelium which becomes the nucleus of the cyst, histologically the author believes that

Fig. 722.—Multilocular cyst of mandible. (*Dr. Dean Lewis.*)

epithelial cells, drifting into submucous tissue, point to the cause of the cyst. This opinion is also held by Buchtmann, who states that "the epithelium was derived from in-growths of gingival epithelium along sinuses following suppuration or extraction of diseased teeth." It is not easy to explain why misplaced epithelium may, under certain conditions, develop teeth which become the nuclei of dentigerous cysts or develop multilocular cysts or develop carcinoma. It would seem that squamous epithelium, when misplaced, would develop carcinoma instead of cysts, tooth enamel, etc. It was the opinion of Nelaton, Diday and Guibot that these cysts originated from simple follicular cysts. The explanation of the origin of these cysts given by the author is further elucidated by Falkson who, in

1879, pointed out that the epithelium from multilocular cysts produces the enamel and that these cysts also have origin from enamel epithelium. Melassez confirms the statement of Falkson.

As previously pointed out in this chapter, a great mass of so-called epithelial débris is left in the submucous tissue during tooth development and from this these cysts develop. Metastasis does not follow, as infection of the parts seldom occurs.

Senn states that multilocular cystic conditions of the jaws are uncommon. In 1901 Stensland reports a collection of 21 cases representing typical multilocular cysts. Bland-Sutton holds that many so-called multilocular cysts are endotheliomata of the jaw, which simulate the former to some degree.

The age at which these cysts most commonly appear is thirty-five years, though congenital tumors, supposedly of this character, have been described (Massin). One has been observed by Coots in a child six months of age. Bland-Sutton regards them as an abnormality of adult life. He believes that they do not originate from enamel epithelium. If so, they would develop at an earlier period of life.

In the author's opinion, Bland-Sutton is in error, since the epithelial cells may lie dormant in the submucous tissue until advanced life, at which time they may become irritated by disease of the surrounding tissue, trauma, etc. This is sufficient to promote cell multiplication with cyst formation.

A malposed tooth or irritation from any cause may be the nucleus of a multilocular cyst. Match workers, painters, lead workers, and those working in smelters are especially liable to the formation of cysts.

Pathology.—Multilocular cysts are usually regarded as benign. The structure of the surrounding walls, however, may degenerate, following which a malignant growth may be developed. The opinions of authors are not in accord as to the pathology of these conditions. The mandible and maxillæ become the point of location of epithelial cells by reason of the infolding of the mucosa in the development of the enamel-organ of teeth, which so frequently leaves the epithelial cells in groups within the submucous tissue and we have the nuclei of carcinoma which may lie dormant many years, finally to be excited into activity and proliferation by reason of some local irritant. Thus we have the inception of carcinoma or, under certain conditions not explainable, the development of cysts. A multilocular cyst may be benign, yet become an exciting factor in promoting the multiplication of epithelial cells, as above described.

The fact that multilocular cysts develop later in life from follicular cysts and sometimes are associated with malignant growths strongly points to the doctrine of Cohnheim that carcinoma has its origin from misplaced epithelial cells which become active and multiply as the result of irritation.

Signs and Symptoms.—Multilocular cysts are distinct in type. On casual examination they may simulate an osteo-sarcoma, a dentigerous cyst or Hydrops Antra, but, by a more careful examination and the use of

radiography, the true pathological characteristics are clearly defined. They are more common in the mandible than in the maxillæ. Periosteal and follicular cysts are found more frequently in the maxillæ than in the mandible. The bone is expanded by the development of the cysts, which communicate with one another. Becker believes that their appearance more frequently in the mandible than in the maxillæ is more apparent than real, as they sometimes extend into the antrum and are often regarded as something else, the real conditions not being recognized.

The location in the mandible in which they develop is in the neighborhood of the first molar and bicuspid teeth. This is to be explained by the fact that the first molar teeth are more commonly diseased than any others and, therefore, become an exciting cause of disease in the surrounding parts. The disease, however, may extend into the ramus of the bone. Multilocular cysts are slow of growth. Heath reports one of thirty-five years' duration, Mellassez one of twenty-three years', Neubolt one of twenty years', Trezebecky one of ten years', Kruse one of eighteen and one of ten years' and Dean Lewis reports one of fourteen years' duration.

Pain is a feature of the early development of the cyst. As the parts distend, the pain gradually subsides, when the further development is usually painless. Pain may result, however, from pressure on the surrounding nerves. The cyst may develop to an enormous size. Bryk describes one of a circumference of 55 cm., extending as low as the second costal cartilage. Forget and Allgayer have also described cysts of great size.

Diagnosis.—It is very important in making a diagnosis to differentiate between a cyst and a neoplasm. The diagnostician should not be confused in reaching his conclusion, but should make his diagnosis by exclusion. Too frequently cysts have been regarded as malignant growths and extensive operations have been made, involving the removal of large sections of normal bone, a step which is wholly unnecessary and which is positively detrimental to the well-being of the patient since the deformity following can never be overcome. Moreover, the diagnostician, taking the view that the malady is malignant, may unnecessarily defer operation until the entire bone is riddled and destroyed to such an extent that the process of repair following operation cannot restore the normal contour of the face.

The epithelial columns and projections are usually present. The epithelial-lined cysts, grouped together, and stellate and polypoid cells degenerated into colloid masses within the cystic walls are characteristic of their development and are a means of identifying the cyst.

From the foregoing description of multilocular cysts, we summarize the essentials in diagnosis as follows:

Occupation; history of the development, including diseases of teeth; trauma; pain; absence of teeth; crowded condition of teeth; exposure to influence of phosphorus, lead or mercury; specific disease, etc.

In the involvement of the mandible, the diagnosis is not difficult. The distention of the walls of the cyst occurs slowly. When the walls of the cystic cavity become thin, fluid may escape so as to be detected by palpation. The skin and mucous membrane remain flexible and are freely movable over the distended tissues unless there has been inflammation which has caused adhesions or infiltration.

Transillumination may be employed to advantage sometimes in outlining the extent of the cyst; exploratory incisions may be made and the true nature of the malady determined, but the most satisfactory means of diagnosis is the Röntgen photograph (Fig. 723). This reveals the multilocular character of the cyst, if such it is.

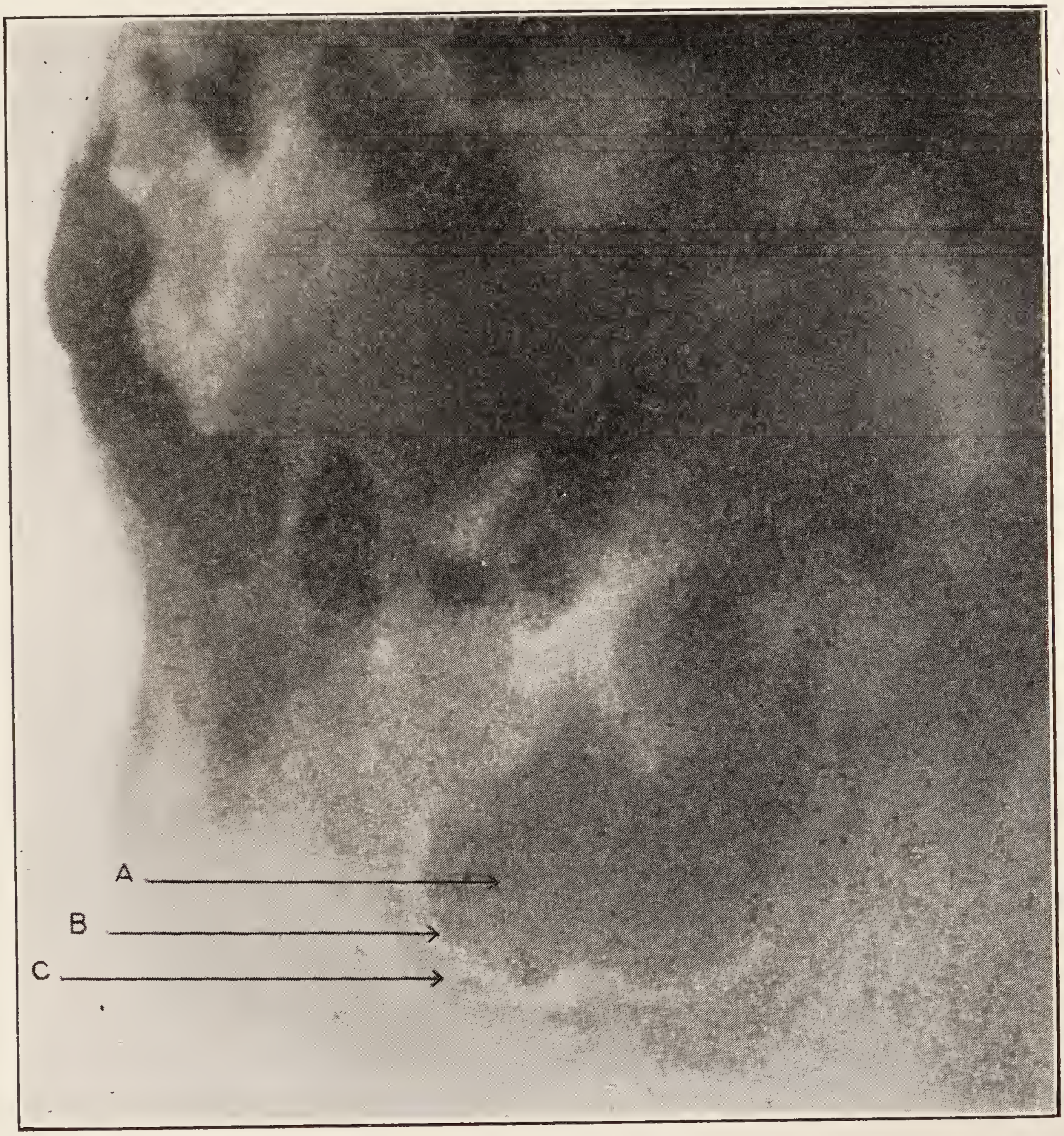


FIG. 723.—A, Bony cyst filled with bismuth; B, zone of granulation; C, bony wall of cyst. Cyst of mandible which existed twenty years. This was opened and injected with bismuth paste and was healed out in six months. (*Dr. Emil G. Beck.*)

In any event whatever may be the nature of the distended tissue—whether a solid tumor, osteosarcoma, dentigerous cyst, fibrous tumor, osteofibroma, a simple cyst or a multilocular cyst—the Röntgen photograph will clearly outline its nature and extent.

Treatment.—The duty of the surgeon will be manifested on examination of the Röntgen photograph. The nature and extent of the operation will be clearly indicated. If we have only a cyst to deal with, the operation should be shaped accordingly. If, however, we find a solid growth, a different course should be pursued. A multilocular cyst, involving the maxillæ or the mandible, usually may be thoroughly removed intra-orally. It is essential to remove all of the tissue entering into the structure of the cyst, together with the cystic walls. The bone surrounding the membrane forming the wall of the cyst should be curetted so as to remove all of the cystic cells. Thus thoroughly enucleated, the cyst is not likely to recur. It is essential, however, to keep the wound open and well irrigated so as to promote the formation of healthy granulations in order to re-establish, as far as possible, the normal contour of the parts.

Exsection of the mandible for the cure of such a cyst is, by no means, called for since the normal bone should be retained. The surgeon who would remove it has not a correct understanding of the pathological conditions. To remove a section of the mandible causes an irreparable deformity. While it is claimed that partial resection may be followed by recurrence of the cyst, it is far better to leave a bridge of bone and preserve the contour of the face. A large experience in the removal of these cysts confirms the author in his opinion that a thorough curetting of the bone and removal of the entire cystic walls will accomplish a permanent cure. In the removal of a multilocular cyst involving the antrum, thorough enucleation, intra-orally, is followed by complete eradication of the cyst.

Post-operative Treatment.—The treatment following operation consists in the packing of the cystic cavity with medicated gauze for forty-eight hours. Iodoform gauze is preferable. After it is removed, the cavity should be thoroughly irrigated, then repacked. The surgeon should keep the orifice of the wound wide open so as to prevent the lips from uniting and thus forming a cavity within which the fluids will be retained. With the lips of the wound kept open, granulations may develop within the cystic cavity and thus bring repair.

After repeated packings with gauze, extending over a period of two weeks, a wax plug may be made or, preferably, one of gutta percha, shaped to fit the cavity. From time to time the lower part of this plug may be shaved away, thus permitting the formation of granulations at the base and, at the same time, holding the wound open for irrigation and ocular examination. This plug should be retained in position until it is no longer required.

If involving the maxillæ, the antrum or nasal cavity, a plug may be used in the same manner, keeping the large wound open through the alveolar border, canine fossa, etc., but it should not extend so deep as to interfere with the healing of the surface of the walls of the cavity. It may be removed, however, day by day for the purpose of irrigation and ocular examination. As in the case of the plug in the region of the mandible, it may be dispensed with as soon as the walls of the cavity have thoroughly healed.

CHAPTER XXXV

MAXILLARY AND MANDIBULAR TUMORS

ODONTOMATA

Definitions.—The word odontomata is derived from the Greek, odontos—a tooth, and oma—a tumor. An odontoma, therefore, is a tumor of dental tissue, a tooth tumor. It may be composed of groups of the various tissues which enter into the structure of teeth. These tumors not infrequently are found in the lower animals, such as sheep, goats, lions, bears, horses, elephants and others. The definition of odontoma given by Bland-Sutton, Dennis, Broca, and others, with their classification, seems complicated and not sufficiently terse. To be precise and present this subject clearly, I would define an odontoma as a tumor composed entirely of tooth tissue. It may be made up of enamel, cement or dentin. Two or more of these tissues may be included in the same tumor. A cluster of encapsulated teeth is no more an odontoma than a group of sesamoid bones would be an osteoma. In my experience as a teacher, I have found that the plainer definitions can be made, the more easily the student comprehends their meaning. Every student of medicine and dentistry understands the names of the different elements entering into the structure of a tooth, therefore it is better to name these tissues, describing the pathological changes which may take place in them.

In designating a tumor, I name the tissue of which it is composed. It has been my policy, in preparing this book, to avoid the use of terms which would be confusing to the reader. Further, I have attempted to avoid the addition of new terms, except where I have felt that they better expressed the thought to be conveyed. In the subject of Odontomata, I have made use of terms which include the anatomical structure of the tooth. These give a distinct understanding of the character of the growth. I would, therefore, class odontomata as follows:

1. Enameloma—a tumor of the enamel.
2. Dentinoma—a tumor of the dentin.
3. Cementoma—a tumor of the cementum.
4. Mixed odontoma—a tumor of two or more of the above tissues.

This classification covers all of the growths of tooth structure.

The essentials to be considered in discussing this subject include the origin and pathological aspects of these tumors. The only odontoma which does not seem to be in accord with my classification is the fibrous odontoma described by Dennis. Should a growth occur from the capsule surround-

ing the tooth before eruption, it must necessarily be composed of tooth structure. This capsule is also known as the dental follicle. Broomell states: "The walls of the follicles are made up of two layers; the outer layer is dense and firm and finally becomes the dental periosteum; the inner layer is thin, frail, in the recent state somewhat transparent, and at an advanced period assists in the formation of the cementum." I believe, therefore, that the tissue developing from the follicle, when excessive or abnormal, must necessarily be a cementoma. These fibrous tumors must, therefore, be classified as cementomata.

A tumor composed of a mass of teeth imbedded in bone is not a tooth tumor. It should be classified as a dento-osteoma.

Bland-Sutton describes tumors which arise from teeth germs, as follows:

1. Those which develop from the enamel organ—epithelial odontomata.
2. Those which develop from the capsules—fibrous odontomata; and from the cementum—compound follicular odontomata.
3. Those which develop from the papilla—radicular odontomata.
4. Those which are formed from the entire germ—composite or ordinary odontomata.

Bland-Sutton has, therefore, classified odontomata according to their source.

In Broca's "Treatise on Tumors," odontomata were classified as to the period of their origin. He divided them into four classes: odontomes embryoplastiques, odontomes odontoplastiques, odontomes coronaries and odontomes radiculaires. Broca's teachings and the teachings of Sutton do not differ widely.

Dennis[1] describes odontomata as follows: "The tumor takes its origin from a tooth germ; if the tumor arises from the enamel, it is termed an epithelial odontoma; if from the fibrous tissue, a fibrous odontoma; if from the tooth follicle, a follicular odontoma; if from the tooth cement, a cementoma; if from the crown of the tooth, a radicular odontoma; and if from all the tooth structure, it is termed a composite odontoma.

The *epithelial odontoma* usually occurs about the twentieth year and is generally found in connection with the horizontal portion of the inferior maxilla (the mandible). The tumor is enclosed in a capsule within which are the multiple and diminutive cysts, varying in size and shape and containing a coffee-colored mucoid fluid. The histological structure consists of columns of epithelium which divide and subdivide and, in some cases, branches of one column are ingrafted upon that of another. If ulceration occurs in the mucous membrane, the appearance is very similar to epithelioma for which it must not be mistaken.

The *fibrous odontoma* consists of a tooth contained in its sac, which has become so thickened by the deposit of fibrous tissue that it will not permit the escape of the tooth. In consequence of this environment, the develop-

[1] Dennis' System of Surgery, vol. iv, p. 59.

ment of the tooth is arrested. In the meshes of the fibrous sac chalky concretions are often deposited. This variety of odontoma may be situated in the ramus of the jaw or in the maxillary portion (the maxillæ) and project into the antrum, especially in children at the time of the eruption of the second teeth.

The *follicular odontoma* is a tumor occurring between the tenth and twentieth years and is formed by the union of several denticles. The capsules connect with each other and ossification occurs in the membrane. Thus the union of several denticles forms a compound follicular odontoma and, when one tooth alone is involved, a simple follicular odontoma is developed. The latter may involve the permanent teeth, notably the molars. If the wall of the cyst is very attentuated, egg-shell crepitation may be present. The cyst contains the tooth surrounded by a viscid fluid. The tooth may be found in its proper position or may be turned upon its side or inverted. The cysts may be bilateral or they may be multiple. The surgeon should examine to see if the tooth has appeared, as its absence points to a diagnosis of a follicular odontoma, since this variety can only exist in connection with the non-appearance of a tooth or teeth.

Cementoma is a tumor composed of a tooth which is lodged in a hard substance like cementum and surrounded by a capsule, which is not only enlarged, but very much thickened by the increase of fibrous tissue.

A *radicular odontoma* is a tumor composed of dentin and cementum and grows from the roots of the tooth since, in the process of evolution, the crown of the tooth is already formed.

The *composite odontoma* is composed of different structures which enter into the formation of a tooth. Usually several tooth germs are united so as to form an irregular mass which bears but little resemblance to a human tooth. In about two-thirds of the cases the tumor is situated in the ramus of the jaws and in the other third in the maxilla. If it springs from the upper jaw, it may invade the antrum and produce deformity of the face."

Partsch divides odontoma into soft and hard. The former, no doubt, is identical with the central epitheliomata. Ordinary odontomata (Broca's odontoplastic odontoma) are very rare. Krogius in 1895 could find only eighteen cases in the literature and since then five have been added. With the exception of three, all patients were twenty-six years old; five cases were under twelve years. There was no difference in the sex. Nineteen of the cases were in the mandible, the molars usually being involved, some of which were supernumerary. Odontomata, in man, are usually encapsulated in the shell of the bone. If, from any cause, the shell breaks, a sinus forms. They may become as large as an egg, causing quite a marked deformity.

Pathological Anatomy.—The bulk of an odontoma is usually dentin, though it may include enamel and cement. It is more or less round in form with irregular walls. On digital manipulation, it is found to be hard, although some parts may be soft, and septa of bone may pass through the

body of the tumor. Enamel may be found, but cement or osseous tissue is rare. A cross section shows a very irregular arrangement of the dental tissues. In twelve out of twenty-three cases reported in the literature, a tooth was the basis of the tumor. Odontomata involve only the permanent teeth. A careful search of the literature does not furnish a single instance of these tumors affecting deciduous teeth.

Enamelomata are tumors of the enamel and are always embryonal. Enamel is a product of the epithelium. This dips deep down into the sub-

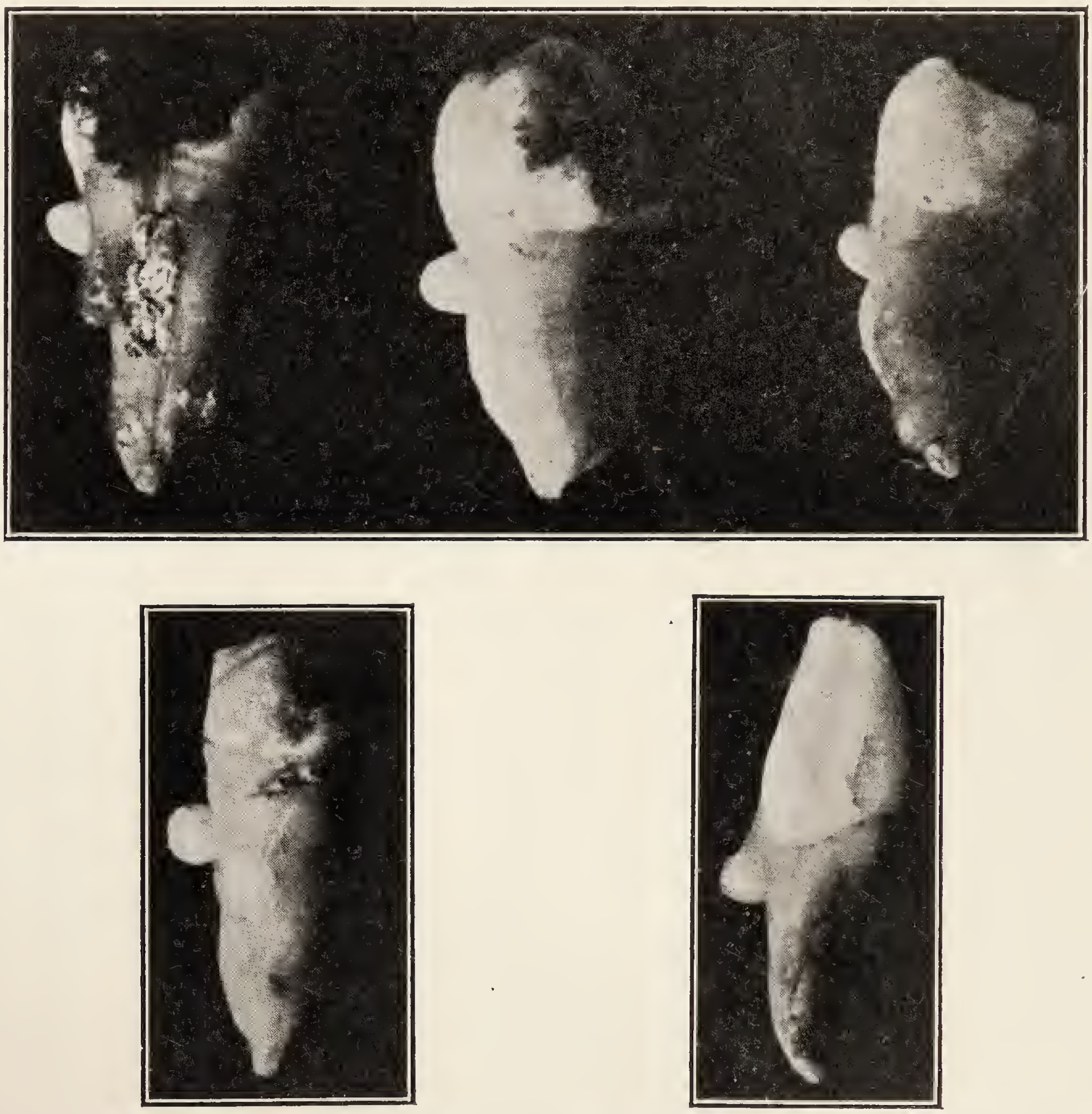


FIG. 724.—Enamelomata which became adherent to the cementum and there developed. (*Royal College of Surgeons.*)

mucous tissue and then within its fold the enamel develops (Figs. 373 to 381). Through some influence, these enamel-forming epithelial cells sometimes become misplaced and zones of enamel develop quite independently of that part which enters into the structure of the tooth crown. These enamel centers become attached to the cementum and form tumors. This growth is an enameloma (Figs. 724 to 727). Fortunately, an enameloma does not attain a large size nor does it cause marked inconvenience. It may, however, cause irritation of the pericementum and lead to complications which

require treatment. These tumors are not of frequent occurrence. They are embryonal in development and do not increase in growth after they are formed.

Dentinomata are tumors of the dentin, which is a product of the sub-

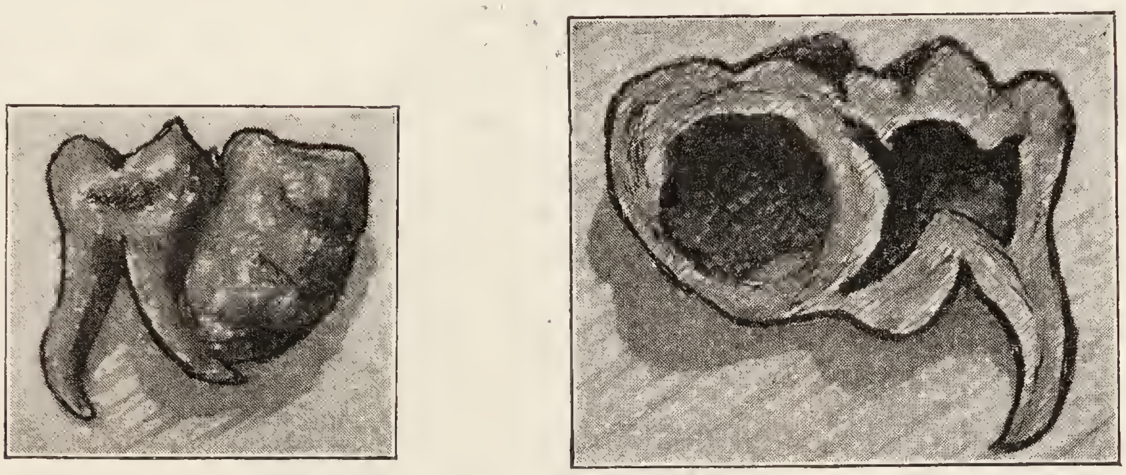


FIG. 725.—Odontoma or enamel deposit on a developed tooth. (*H. E. Friesell, in McCurdy's Oral Surgery.*)

mucous or connective tissue. It is subject to influences which result in abnormal development in tissues elsewhere in the body and may, therefore, under the stimulus of irritation, develop a well-defined dentinoma (Figs. 728 to 731).

Cementomata are tumors of the cementum, which is a product of the pericementum. They are more prevalent than any other form of dental tumor which is composed of a single element of the tooth structure (Figs. 732 to 734). The pericementum, as its name implies, surrounds the cementum and is subject to diseases and injuries incident to the teeth. Not infrequently, trauma from any source may excite a periosteitis with an accompanying pericementitis, which becomes the initial lesion for a cementoma. There is no marked difference between a cementoma and an osteoma. The former is surrounded by pericementum, while the latter is surrounded by periosteum. Both develop from persistent irritation, having, in some instances, a predisposing cause, such as the eruptive fevers, syphilis, etc. Cementomata are common in horses, where they grow to enormous sizes. They occur in man but seldom without bone or dentin being mixed with them. The fibrous odontoma of Dennis and the radicular odontoma of Sutton not infrequently are pure cementomata.

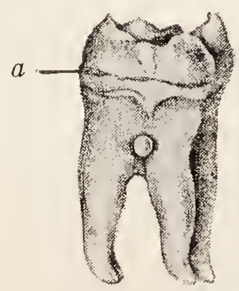


FIG. 726.—Nodule of enamel on the posterior surface of a left molar tooth in the upper jaw. The enamel surrounded by a ring-like layer of tartar (*a*) shows a flattened, adherent thorny process, the point of which is directed toward the middle of the nodule. (*Heider.*)

Mixed odontomata are tumors which include in their substance two or more elements of tooth structure (Fig. 735). A deformed tooth is not an odontoma unless the deformity is marked by an abnormal growth. The tumor may include enamel dentin and cement and may attain a great size (Fig. 736). If innumerable teeth are held together in one mass by cement, thus forming a tumor, it is an odontoma.

The dental follicle may contain many teeth which become fused, or the walls of many follicles may be so ruptured that the teeth, while in the plastic state, become cemented together in one great abnormal mass and form an odontoma.

FIG. 727.—Section of the same nodule. The obtuse cone of dentin is capped by a thick layer of enamel. The latter is highly pigmented, especially toward the external surface. The base (*a*) of the cone is in immediate connection with the normal dentin. (× 50.) (*Heider.*)

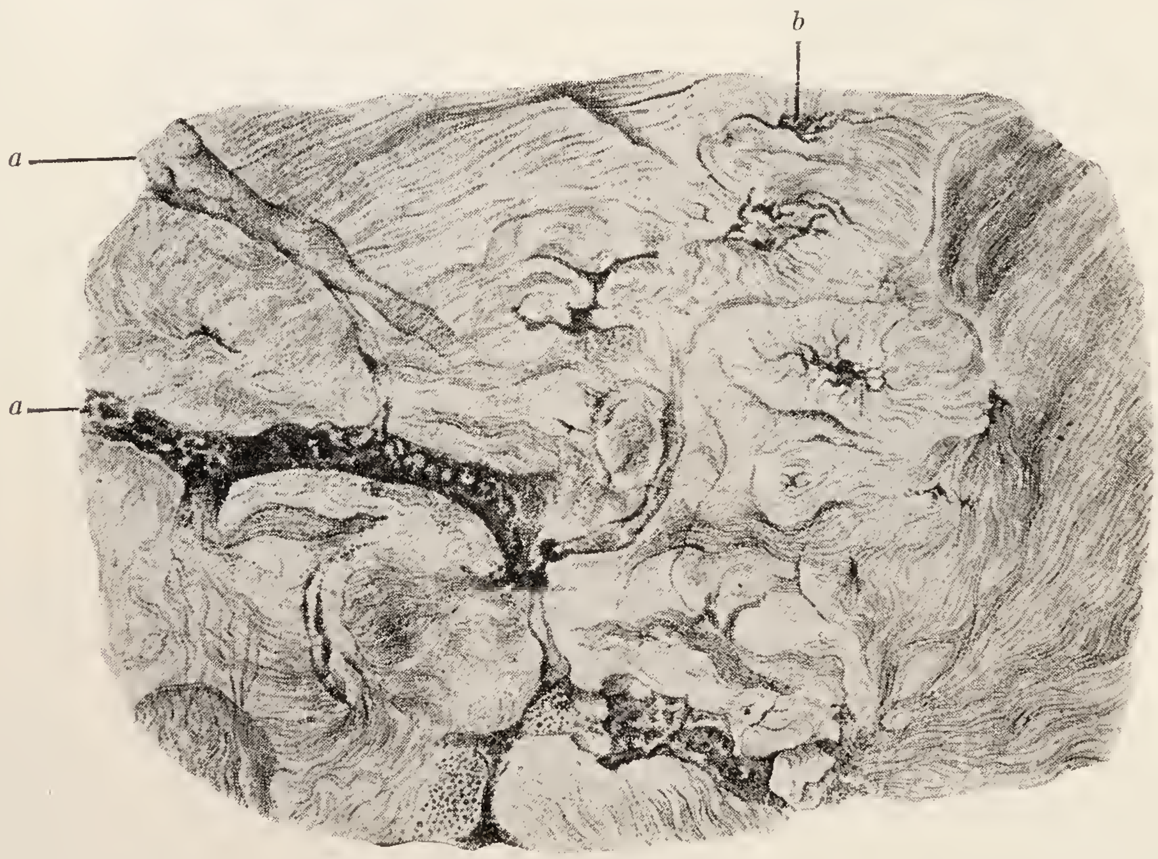


FIG. 728.—Multiple dentinal new formation intruded between the dentin of the root of a molar tooth. The canal of the root is bifurcated (*a*, *a*). *b*, Canals in newly formed dentin. (× 100.) (*Heider.*)

Dentigerous cysts are teeth or denticles surrounded by a capsule (see chapter on Cysts).

Dentocystoma is a dentigerous cyst whose wall has taken on growth.

FIG. 729.

FIG. 730.

FIG. 729.—Wart-like tumor of dentin fixed by a small pedicle to the wall of a pulp cavity in a molar of the mandible. The tumors are smooth, rounded and transparent, having an amber color. (× 2½.) (*Heider.*)

FIG. 730.—Transverse section of dentinoma which nearly filled the pulp cavity of a molar whose crown was much worn. The section shows a latterly situated nucleus. The dentinal tubes have been cut transversely in the central part. (× 20.) (*Heider.*)

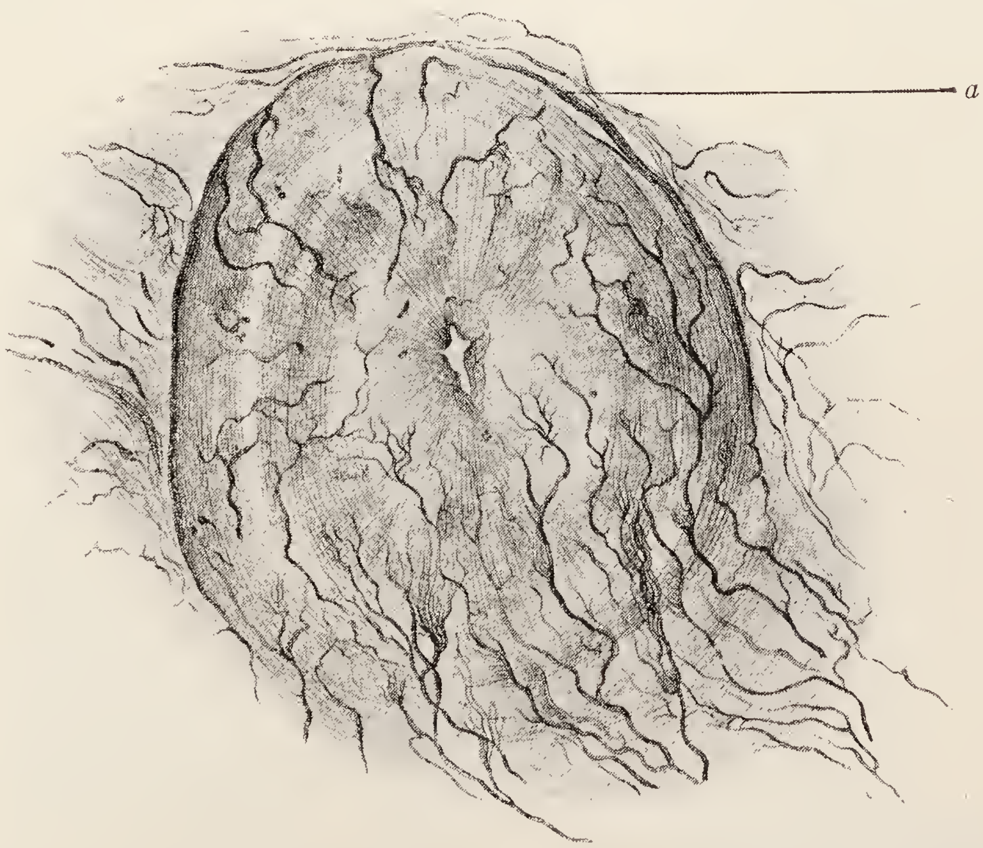


FIG. 731.—Newly formed dentin near the junction of the root canal and pulp cavity in a molar of the upper jaw. *a*, Elliptical curve marking separation between tooth dentin and newly formed dentin. (× 500.) (*Heider.*)

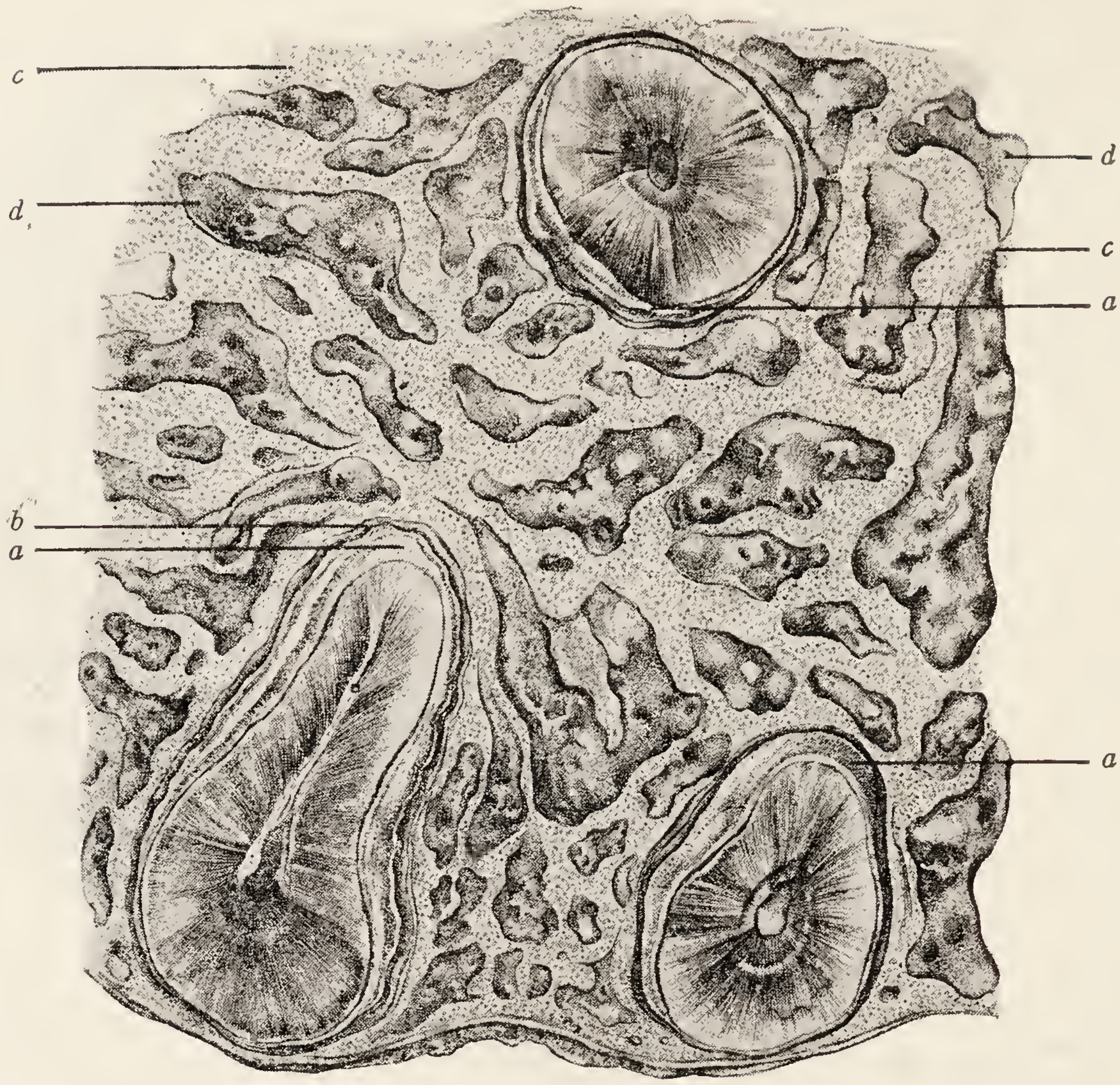


FIG. 732.—Unilateral hypertrophy of cementum on three transversely cut tops of the roots belonging to a molar of the upper jaw. The osseous substance still surrounds them. The thickened cementum does not equally enclose the dentin, (*a*, *a*, *a*). The periosteum of the root (*b*) is proportionally stronger. The lamellæ of bone (*c*, *c*) extend between the roots of the tooth. (× 10.) (*Heider.*)

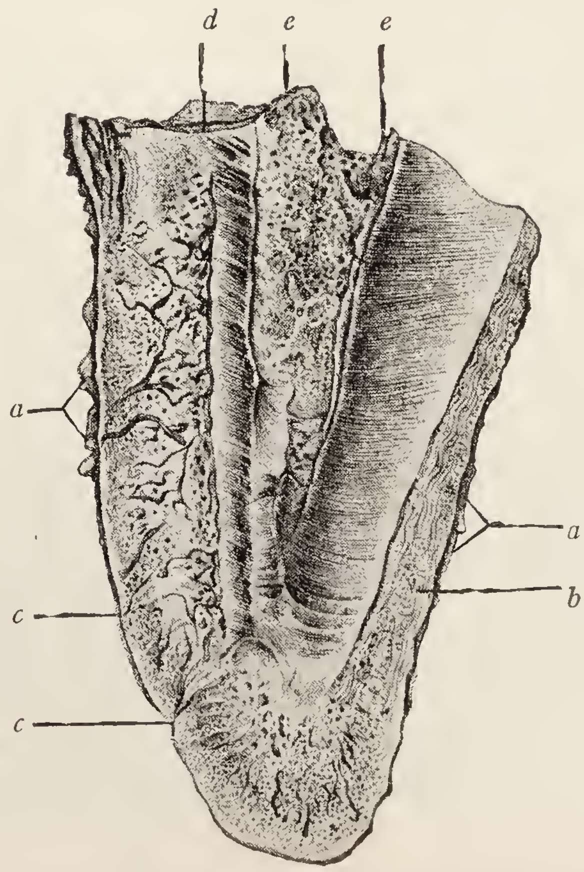


FIG. 733.—Hypertrophy of cementum with many calcified canals in the dentin at the top of a root. *a*, *a*, Remains of thickened and dull periosteum; *b*, undulating layers of cementum; *c*, *c*, irregular holes penetrating the superficial cementum; *d*, ramified canals in dentin; *e*, *e*, resorption of dentin. (× 6.) (*Heider.*)

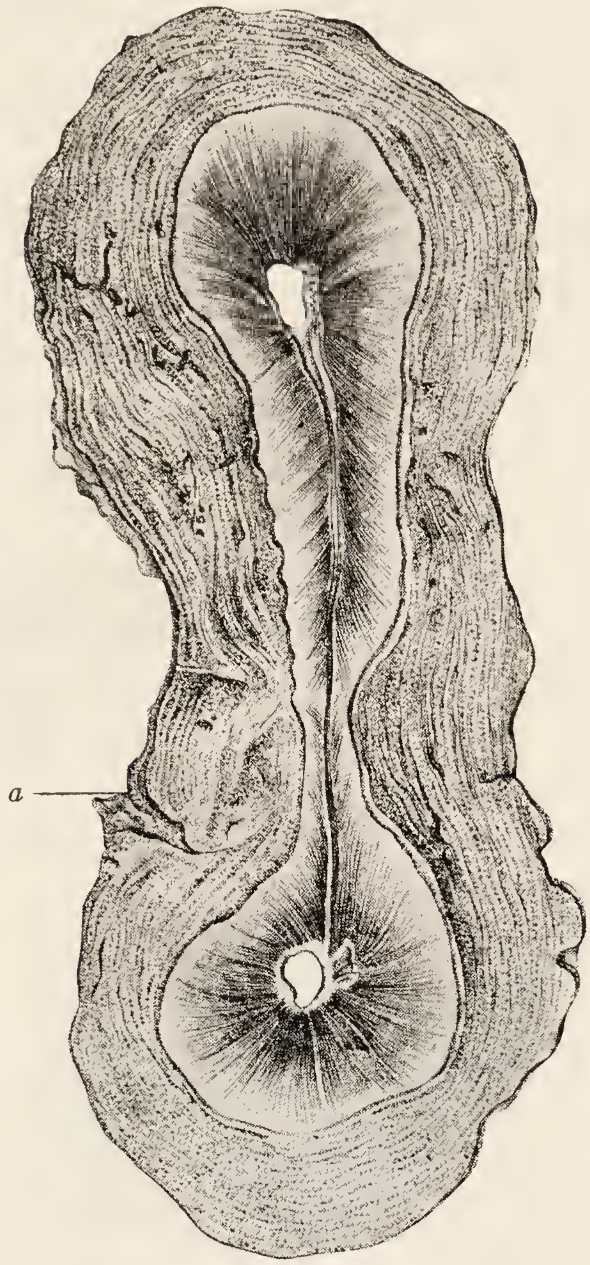


FIG. 734.—Highly developed concentric hypertrophy of cementum on the transversely cut tops of the roots from a molar of the mandible. Canals for vessels, similar to the Haversian canals in bones, cross the cementum in several directions. *a*, Thickened periosteum of root dipping into the cementum. (× 10.) (*Heider.*)

FIG. 735.—Impacted cuspid tooth lying immediately beneath the orbit. Beneath it was a well-defined odontoma. Central incisor in relation to the odontoma in exactly the condition in which it was found. Patient sixty-three years of age. Right incisor became loose, was removed, odontoma discovered and removed, and still above it a cuspid tooth was found and removed. This was prior to the advent of Röntgen photography.

Dento-osteoma is a tumor in which there is a development of teeth or denticles in a matrix of bone without surrounding fluid. My observation of these tumors leads me to believe they are not uncommon.

Symptoms.—An odontoma may develop from a nucleus formed by a supernumerary or permanent tooth. Its growth is insidious and benign, causing little inconvenience until it has reached a size which disfigures the face. Its growth may not be attended by pain. The teeth in contact with an odontoma are crowded out of their normal alignment. If the odontoma is situated at the union of the ramus and the body of the mandible, irritation of the surrounding parts may lead to partial arrest of motion of the temporo-mandibular articulation. An odontoma may grow to an enormous size. The external appearance beneath the soft parts is not unlike an osteoma, for which it has been mistaken. As its growth increases, making pressure upon the surrounding parts, the patient may complain of neuralgia, since it impinges on the nerves which supply the area.

On examination in the early development, a small swelling is noticed

FIG. 736.—Mixed odontoma.

over the growth. As time passes, the swelling increases. There is no way to distinguish between an odontoma and an osteoma by ocular examination or digital manipulation. A steel instrument brought in contact with the tumor mass by penetrating the soft parts will clearly determine the character of the growth. The experienced operator quickly recognizes the difference in the feel of enamel and bone. The formation of sinuses may occur. An odontoma most frequently appears in the mandible between the cuspid tooth and the ramus of the bone. It may be seen in the maxillæ, though rarely.

Diagnosis.—The diagnosis of odontomata in the early development is attended with difficulty. The entire denture should be examined carefully and any missing teeth noted. The absence of one or more teeth is suggestive of the nature of the disturbance. The most reliable means of making a diagnosis is by the use of the Röntgen photograph. In this way we are able to clearly observe the location, character and size of the growth. Prior to the advent of the X-ray, these conditions were not infrequently mistaken for bony tumors. It has been my experience in getting skiagraphs made, even by expert operators, that the work sometimes is so unsatisfactory that

further effort is called for to procure well-defined plates which clearly outline the tumor in detail. In one instance, I had five exposures made and finally found an impacted tooth approaching the sigmoid notch which was not shown in the previous four.

Errors in diagnosis, which lead the surgeon to excise a portion of the mandible for the removal of an odontoma, are unpardonable. The removal of a section of the mandible, by which the function of mastication is lost and articulation greatly impaired, is little less than a calamity. The surgeon must, therefore, proceed slowly in reaching a conclusion, make a careful diagnosis by the use of a steel probe and as many skiagraphs as need be to satisfy him as to the exact character of the growth.

Conditions which simulate odontomata:

Osteoma.
Osteo-sarcoma.
Dentigerous cyst.
Bone cysts, including multilocular cysts.
Exostosis.
Leontiasis Ossea.
Acromegaly.
Actinomycosis.
Syphilitic gumma of the bone.
Aneurysm.
Abscess.

In *osteoma* the full complement of teeth should be present. In odontoma usually one or more teeth form the nucleus of the growth, yet an odontoma may be formed with a supernumerary tooth as its center. An osteoma usually grows more rapidly and attains a greater size than an odontoma (Figs. 737 and 738). A steel probe brought in contact with bone produces a dull sound, which is to be compared to percussion on wood, but when it strikes an enameloma or a mixed odontoma, it has a sharp, high-pitched, steel-like ring which is unmistakable. In contact with cement the sound has not so high a pitch. Osteoma usually appears later in life than odontoma.

FIG. 737.—A carious wisdom tooth of the mandible with a tumor placed on the roots. (*Heider.*)

Osteo-sarcoma is a disease of middle life and beyond. Not infrequently the surface of the bone is spongy, while the odontoma is dense. Numerous sinuses appear over the surface. Sinuses rarely appear in the odontoma. Osteo-sarcoma also shows signs of malignancy soon after the beginning of the growth and the tissues break down, leaving an ulcerated surface.

Dentigerous cysts, in their early development, simulate an odontoma. Later fluid is found, while in an odontoma none is present. The X-ray will easily differentiate these tumors. This, supplemented by the sharp steel probe, will make the diagnosis final.

Bone cysts, in their early development, are easily mistaken for dentigerous cysts and odontoma. As they increase in size, however, their walls may be easily penetrated and the fluid contents evacuated, while an odontoma remains solid.

An *exostosis* is the result of friction, as a rule, or an irritation of the periosteum which results in a deposit of new bone. This may develop almost to any extent. The mass of bone is without cavities. Although an exostosis consists only of bone, it has a density more nearly approaching an odontoma than any other tumor. The X-ray will easily differentiate them.

Leontiasis ossea is a bone tumor characterized by a fine, sponge-like

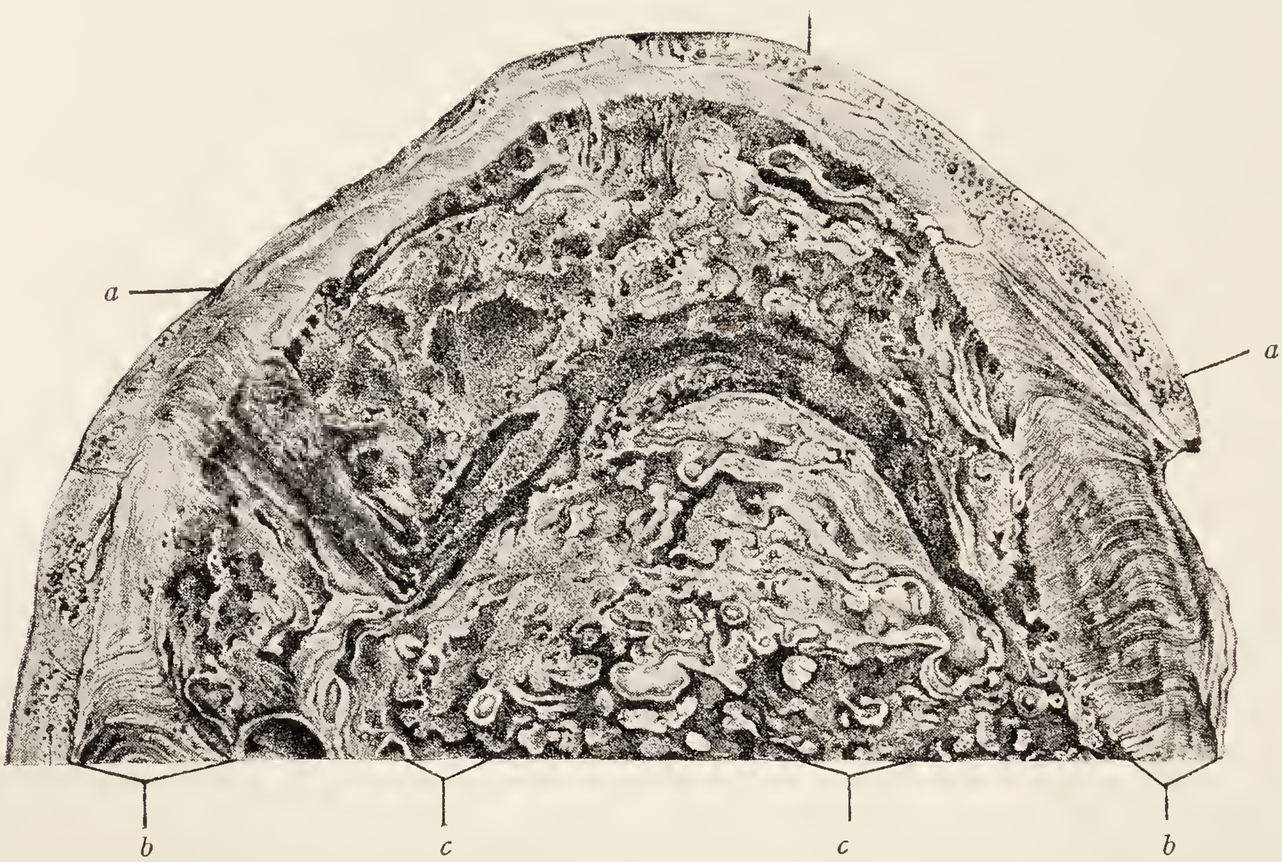


FIG. 738.—Transverse section perpendicular to the surface of the tumor seen in Fig. 737. The enamel is totally absent. The surface is everywhere covered with a proportionally small layer of cementum (*a*) and is permeated by numerous holes and canals. Next appears a concentric layer of dentin (*b*). The principal mass, or parenchyma, consists of osseous substance (*c*). (× 10.) (*Heider.*)

appearance. The instrument readily passes into its substance. It, too, is of slow growth, but it lacks the density of an odontoma. Leontiasis ossea usually affects the maxillæ, one side being involved, while odontomata are found more frequently in the mandible.

Acromegaly is a growth which involves the entire mandible and should cause little trouble in the diagnosis of this condition.

Aneurysm, abscess, actinomycosis, gumma and other cysts may cause distention of the jaws, but they have decided characteristics which would clearly define them. For further explanation regarding each of these, see the chapters dealing with the various diseases.

Treatment.—An odontoma should be treated surgically. By the aid of a good skiagraph and with a clear understanding of the location and ex-

tent of the tumor, the operation can be performed safely. The many errors in diagnosis of the past, the irreparable deformities resulting from misconception of the true nature of the disease, the removal of half of the mandible and large sections of the maxillæ cause us to pause and enter deeply into the subject of making a diagnosis. Once the tumor is circumscribed, the surgeon can remove it, preserve the surrounding tissues and leave no permanent deformity.

These tumors should be removed intra-orally. There is no odontoma which calls for external incisions. The soft parts should be divided, the bone denuded of the periosteum and the overlying bone removed so as to expose the odontoma. This may be done best by means of a dental or surgical engine, which will remove only the overlying bone without sacrificing more than is necessary to admit of lifting the tumor from its bed. In extremely large growths we may find that the bone has been so weakened by absorption of its substance that great care must be exercised to prevent fracture of the thin bony walls during the operation. A case came under my observation in 1903 in which the odontoma was so large, the bone was destroyed to such an extent that a fracture occurred before the patient was conscious of the true nature of his ailment. This tumor was a cementoma. The growth was from above downward and the bone in the region of the first molar tooth, the center of the tumor, was absorbed so that the mandible was destroyed except a thin ledge which formed the lower border. Under the strain of mastication and without the application of great force, the bone fractured.

After removing the tumor, retaining the fragments by fixing the lower to the upper teeth by wiring and so retaining them over a period of six weeks, we found that the fragments had united. The skiagraph revealed their union, but the bone was so frail at this point that the teeth were retained in close contact three weeks longer, after which the wires were removed when the union was complete.

No matter where an odontoma may be situated, the surgeon should not resort to external incisions in its removal. External incisions in the performance of operations calling for removal of tumors of the mouth, maxillæ or mandible are not called for, except in rare cases. Too frequently incisions are made through the face in the performance of oral operations which might be more easily accomplished intra-orally, besides, the patient would be spared disfigurement.

CARCINOMA OF JAWS

Carcinomatous growths of the jaws are more common than sarcomatous. The relation between the frequency of the latter and the former is two to three.

Following are some comparative statistics from various hospitals and clinics of Germany:

I. Maxilla

Surgeon	Institution	Period	Carcinoma	Sarcoma
Gurlt	Vienna Hospital	1855–1878	125	96
Ohlermann	Göttinger Clinic	1856–1874	19	12
Boyer	Prag Clinic	....	16	10
Küster-Birnbaum	Augusta Hospital, Berlin	....	19	15
Batzaroff	Zurich Clinic	1881–1890	26	20
Beckmann	Würzburg Clinic	....	5	7
v. Petzold	Erlanger Clinic	....	11	4
Martens	Göttinger Clinic	1875–1896	57	27
Stein	Berlin Clinic	1890–1900	53	34
Total			330	225

II. Mandible

Surgeon	Institution	Period	Carcinoma	Sarcoma
Gurlt	Vienna Hospitals	1855–1878	147	83
Windmüller	Göttinger Clinic	1875–1890	25	6
Küster-Birnbaum	Augusta Hospital, Berlin	....	10	7
Batzaroff	Zurich Clinic	1881–1890	2	13
Schmidt	Griefswold Clinic	1885–1902	20	13
Total		....	204	122

Location.—Carcinoma of the maxillæ seems slightly more prevalent than of the mandible. The data are as follows:

Surgeon	Upper	Lower
Gurlt	125	147
Birnbaum	19	10
Windmüller	39	25
Batzaroff	26	2
Total	209	184

Sex.—Divided as to sex, the figures show a marked prevalence of male patients over female.

Surgeon	Male	Female
Gurlt	125	36
Birnbaum	17	12
Batzaroff	16	12
Windmüller	47	18
Total	204	78

Age.—Carcinoma of the jaws is entirely unknown during the first ten years of life, and practically so during the second. Beginning with the third, it increases in frequency until it reaches its maximum between the forty-fifth and fiftieth years. On the basis of German statistics, com-

prising 176 cases of carcinoma, 148 cases of sarcoma and 167 cases of epulis, G. Perthes has devised the following graphic scheme to illustrate their frequency at various ages:

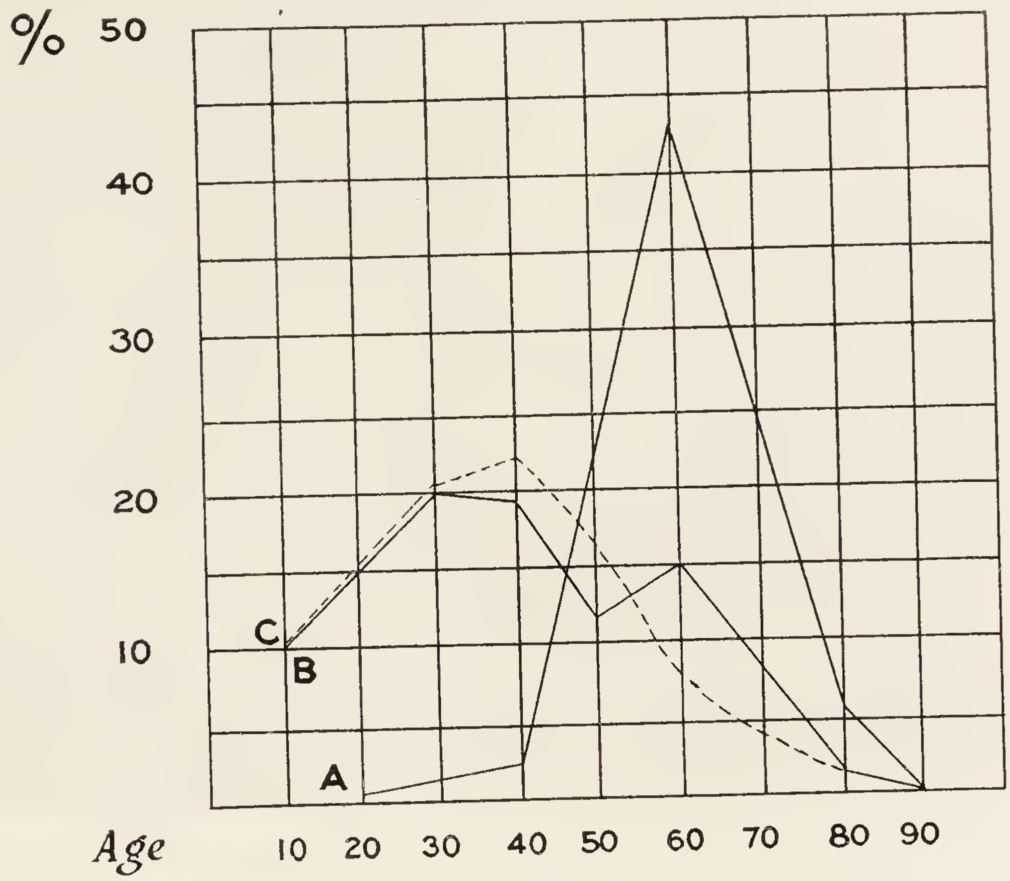


FIG. 739.—A, Frequency of carcinoma of the jaws. B, Frequency of sarcoma. C, Frequency of epulis.

Clinical Varieties.—Carcinoma of the jaws may be primary or secondary. The former originates in the jaw and the latter spreads to it from surrounding structures. Metastatic tumors are seldom found in this locality.

The point of origin of primary carcinoma is furnished by the epithelium of the mandible or maxillæ. At first the growth appears in the form of a papillary tumor or as an indurated swelling (Figs. 740 and 741). The ulcerative process attacks the underlying bone which thickens and then softens, often leading to the formation of small sequestra which are thrown out from areas of necrosis. Histologically, these peripheral carcinomata are usually characterized by squamous epithelium and areas of hornification.

Central carcinoma begins to grow within the bone and is particularly frequent in the maxillæ, which appear swollen in part or as a whole. Later, the soft structures overlying the bone are involved. The point of origin is not always clear. The mucous membrane of the antrum of Highmore is known to furnish the ground for many such tumors (Fig. 742), but is far from being the only starting point. The bone, which is the seat of a central carcinoma, appears swollen, is softened in spots so that it may be easily cut into, and finally its continuity is interrupted by broken-down areas. The antrum is filled with a soft mass until the whole bone is involved in the tumor, the shape of which is generally that of the bone. Secondary ulcerations appear on the neighboring soft structures, including the cheek and

outer skin, though the tumor may be far advanced before this occurs (Fig. 743).

Histologically, these tumors are ordinarily of the cylindrical cell variety.

FIG. 740.—Extensive carcinoma of the left maxilla. An operable case, but the prognosis is unfavorable.

Here and there aggregations of cells may cause the accumulation of a slimy secretion in the mass, leading to the formation of small cysts within the

FIG. 741.—Same patient after operation.

tumor. It is generally believed that cylindrical cell carcinoma of the maxillæ alone has its origin in the antrum of Highmore, but Martens maintains that squamous cell carcinoma may so originate.

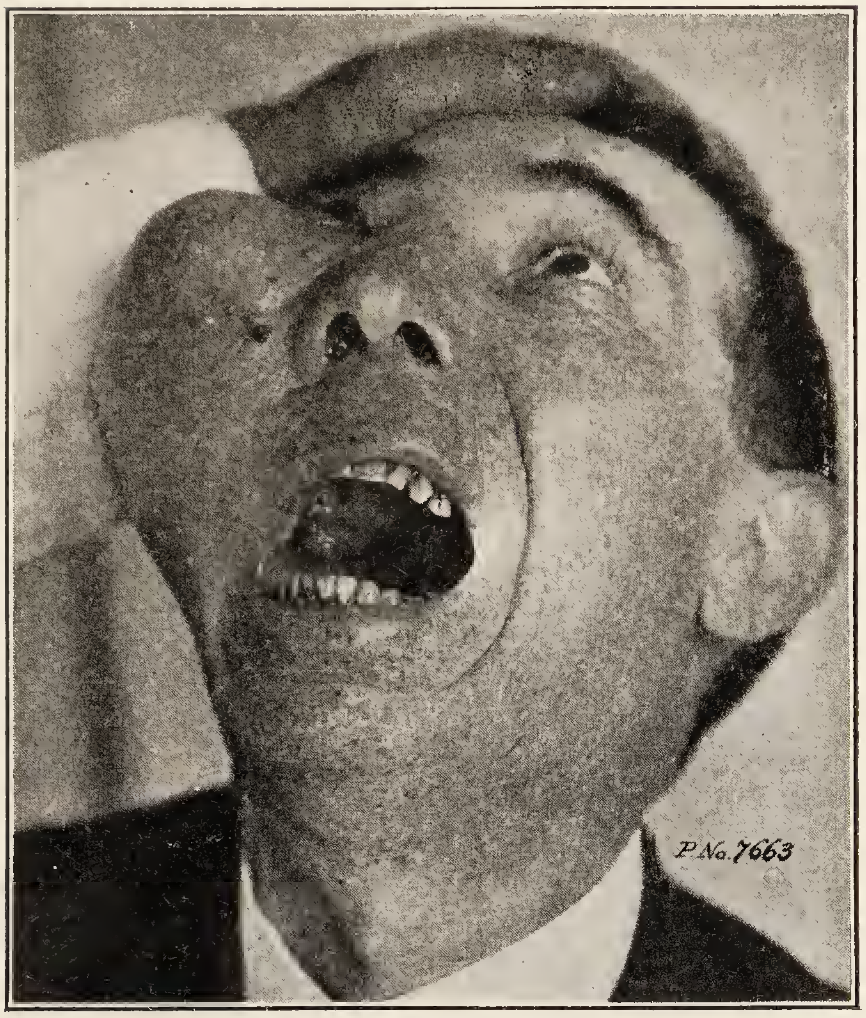


FIG. 742.—Carcinoma of antrum secondary to nasal polypi. White male, age forty-one years. Nasal polypus symptoms seven months. When the photograph was taken the disease had been present about one year. The patient died six months later. (*Bloodgood, in American Practice of Surgery.*)

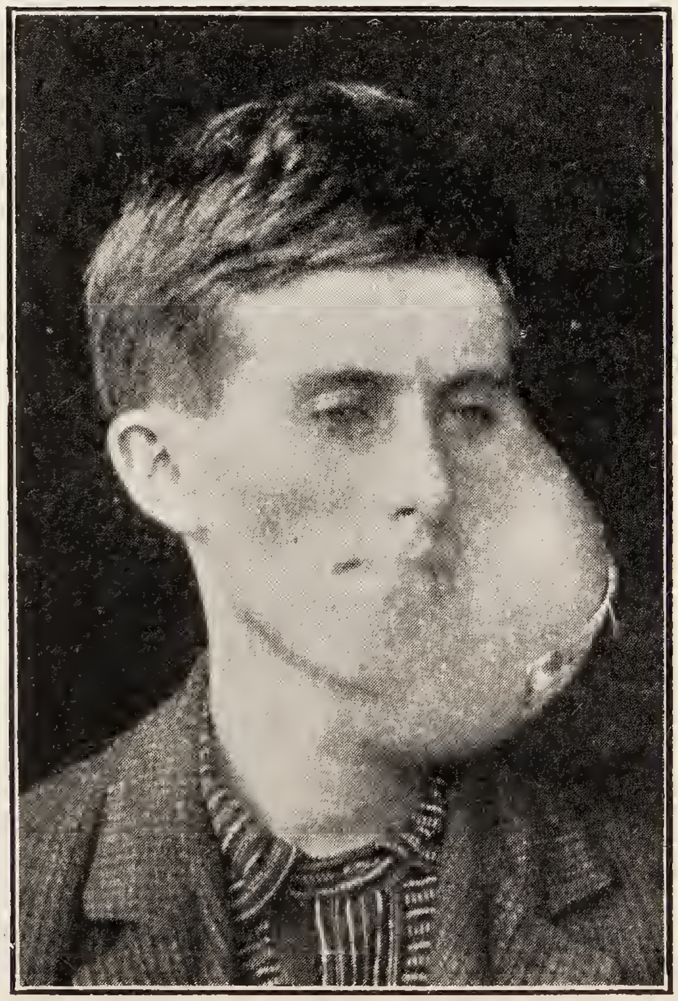


FIG. 743.—Carcinoma beginning in the antrum, secondary ulceration has occurred on the cheek. (*Deichmiller.*)

A number of cancerous growths of the maxillæ present histological characteristics that preclude the possibility of their originating from the epithelium as ordinarily found in the mouth, nose or antrum. They consist of stratified, cuboid epithelial cells showing no tendency to hornification. Their origin is far from clear.

Central carcinoma does not often occur in the mandible (Fig. 744). A squamous cell tumor, originating in the dental or mucous membrane epithelium, may invade the mandible and cause it to become enlarged before any ulceration of the soft structure is observed, thus giving the clinical ap-

FIG. 744.—Central cystic adamantine epithelioma of the lower jaw. White female, aged thirty-seven years; tumor twenty years; resection. Well ten years after operation. (*Bloodgood, Johns Hopkins collection in American Practice of Surgery.*)

pearance of a genuine carcinoma, but careful examination of the excised parts reveals the deception.

Carcinomata of the maxillæ and mandible present features which are peculiar to these bones. They are due to the development and irritation established by teeth. In the eruption of the tooth, its course is diverted and, failing to take its proper place, it remains in the substance of the bone. Here it may become an irritant to the surrounding tissues, which, as a result, take on growth, thus making the tooth the center of a tumor. The cementum may also become enormously thickened, adding to the caliber of the tumor.

These tumors are of slow growth and, in their early development, benign. In the embryo the epithelium dips down into the submucous tissue forming the epithelial lamina, within which the enamel of the tooth is developed. In the process of development, the lamina becomes constricted so as to form a narrow band or cord, which later atrophies, leaving the enamel organ within the substance of the submucous tissue. In this process many epithelial cells are left deposited within the connective tissue and these masses may become the center of epithelioma (Figs. 373 to 381).

Secondary Carcinoma of Jaws.—The points of entry of secondary carcinoma of the jaws are as follows: For the maxillæ, the skin and the mucous membrane of the mouth and nose; for the mandible, the lips, tongue, the parotid, sublingual and submaxillary glands. Under the title of "India-rubber jaw," Cleland has described an unusual case of mandibular carcinoma in which the whole bone was infiltrated with a whitish neoplasm and rendered so soft that it could be sliced with a knife. The growth in this case had probably originated in one of the submaxillary glands. Metastatic carcinoma of the jaws is very rare. Two cases have been reported by Batzaroff, one each in the maxillæ and the mandible, both secondary to carcinoma of the breast.

Etiology.—Many etiological factors in carcinoma of the skin and mucous membrane of the lips are also to be reckoned with in connection with this form of cancer. Chief among them is smoking, either of a pipe or cigarettes, and holding a quid of tobacco in contact with the cheeks. This may explain, in part, why the higher percentage of patients is among males. Sometimes the local irritation or trauma may be caused by particles of food, artificial teeth, etc. A number of patients, though comparatively few, present a family history of cancer of the jaws.

Symptoms.—Carcinoma of the alveolar processes appears at first as a small, round swelling on the gingival mucous membrane, with indurated, sharply outlined margins. Soon the bone is thickened and, at the same time, softened so that it may easily be penetrated. The teeth become loose and fall out. There is some pain, though in the beginning this may be absent. In the maxillæ, the tumor gradually spreads toward the antrum of Highmore, while in the mandible it grows toward the interior of the mouth. In advanced stages the mandible may undergo spontaneous fracture. Otherwise the symptoms in the mandible are very much like those in the maxillæ.

Central carcinomata are ushered in with great pain, the cause of which is usually not understood and, as a rule, a number of teeth are extracted in the hope of relief. The pain is unquestionably due to pressure on the nerves which so abundantly supply the parts. Edema of the nasal mucous membrane on the affected side or the appearance of polypi in the nose often lead the patient to the rhinologist. Sooner or later the bone itself appears swollen, its plates having been forced apart by the growth and reduced partly, or wholly, to mere shells.

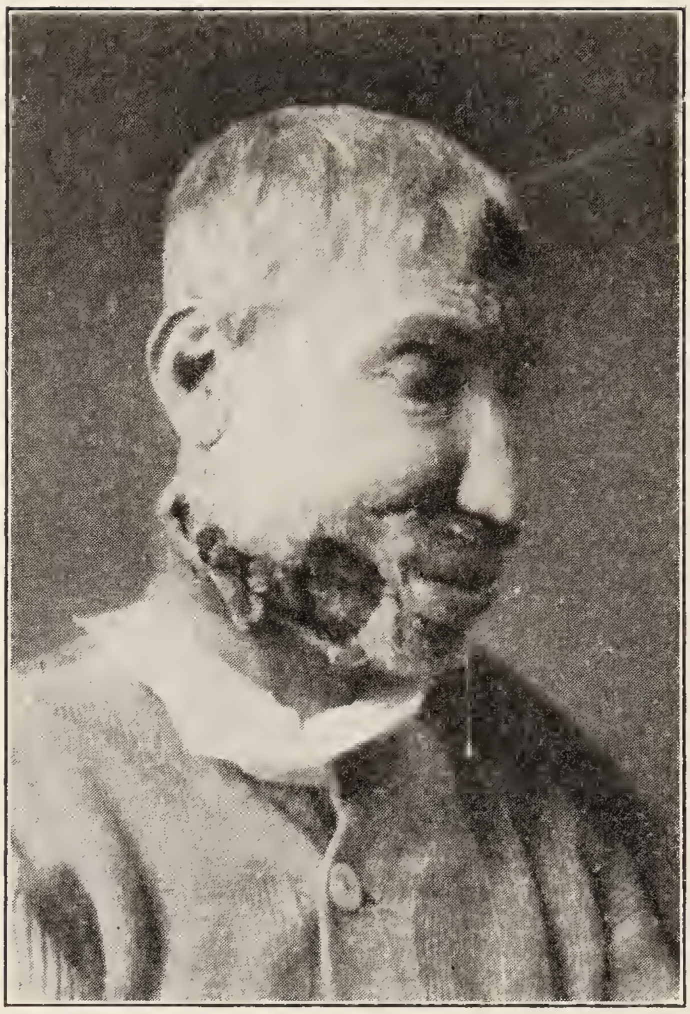


FIG. 745.—Carcinoma of the mandible with metastasis to the glands on the right side of the neck. (*Dr. Deichmiller.*)

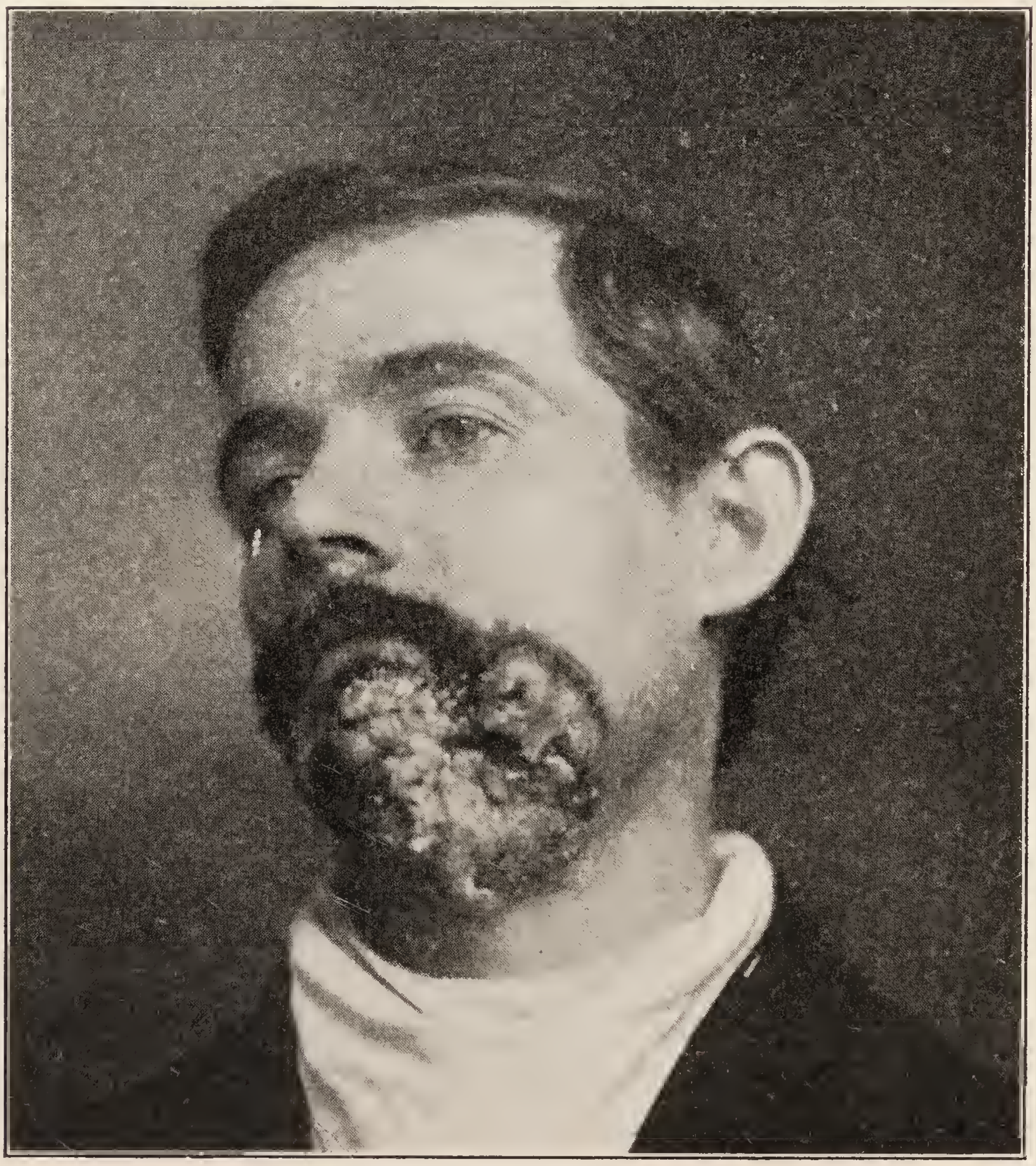


FIG. 746.—Carcinoma of the mandible with extensive external ulceration of the skin.

Pressure symptoms, involving the eyeball, and mechanical disturbances of various kinds follow, the same as in cases of sarcoma. Palpation reveals the mass to be soft, also the bony shell, with here and there harder regions and parchment-like crepitation under the fingers. The soft structures, including the skin, are involved even sooner than in sarcoma. At first the skin adheres to the underlying tissues and becomes lustrous and bluish in

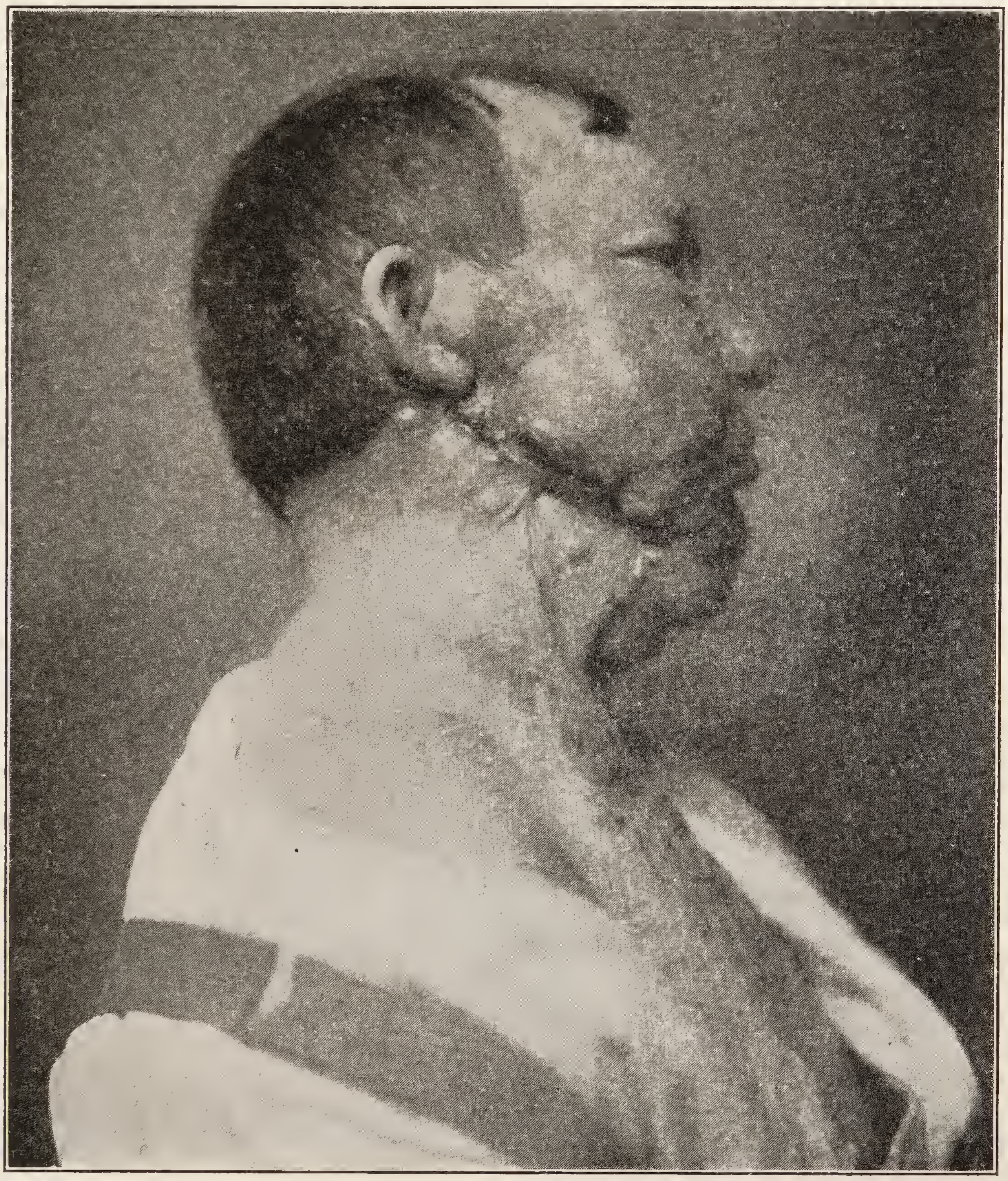


Fig. 747.—Inoperable carcinoma of the mandible involving the entire lymphatic system. This patient had been operated on five times in three years. He came to me for further operation which was declined.

color. Ulceration follows, either leading into the depths of the tumor, like a sinus, or extending over the skin (Figs. 745 and 746). Extensive infiltration of the cheeks and masticatory muscles leads to limitation of motion of the mandible. The ulceration or sinus liberates a foul-smelling secretion, indicating that disintegration of the tumor mass is taking place, and there is an occasional hemorrhage when the ulcerative process involves the wall of some larger branch of a blood-vessel. In those cases of central car-

cinoma of the maxillæ, in which the tumor grows to a very considerable size within the bone before breaking forth, the secretion or hemorrhage finds exit through the nasal cavity.

With the spread of ulceration and breaking down of the tumor, the patient's general strength is undermined and he becomes cachectic. Some of the malodorous material, finding its way into the oral cavity, is swal-

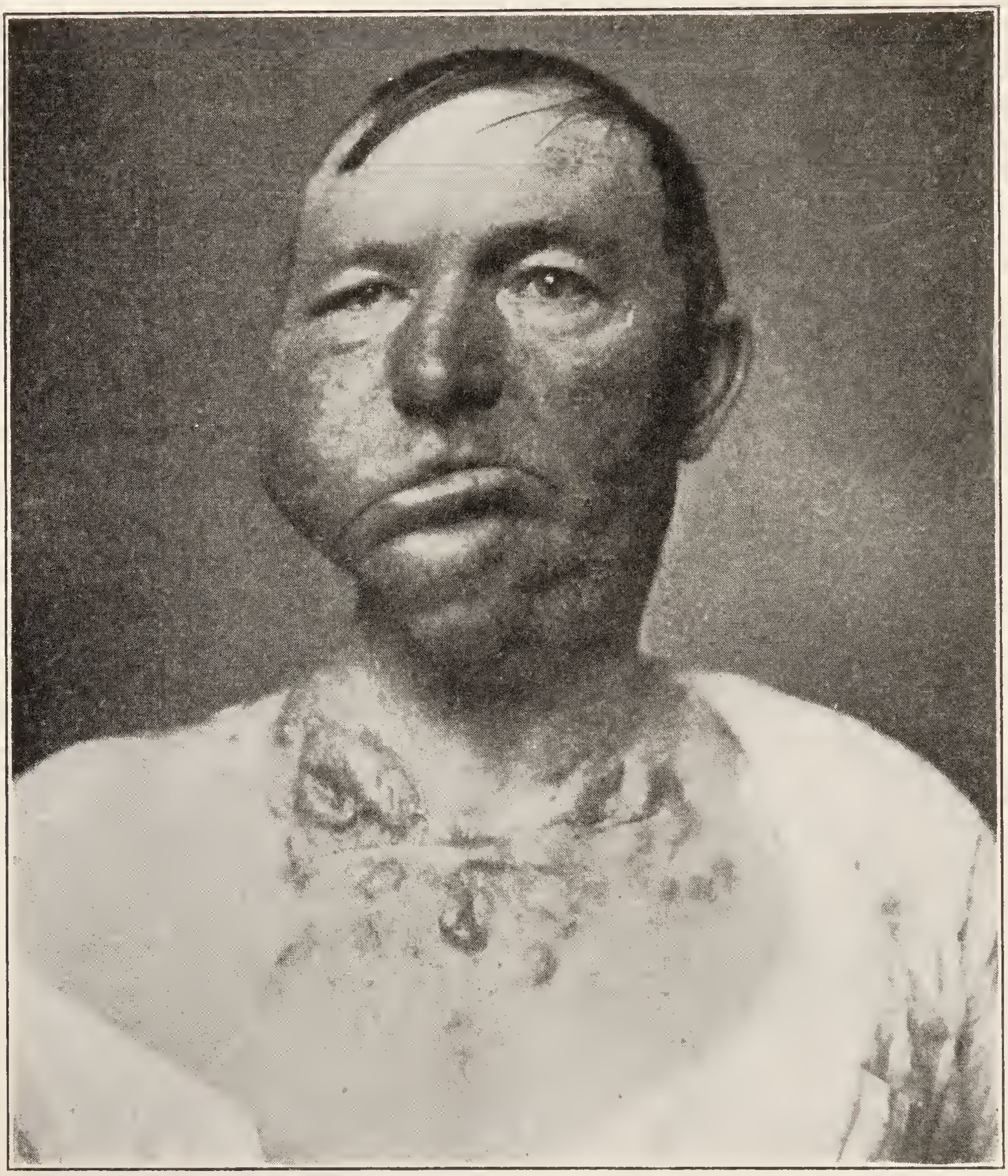


FIG. 748.—Front view of the same patient.

lowed and disturbs digestion, adding to his debility. Finally, the patient may die from sudden hemorrhage, cachexia or aspirative pneumonia.

Metastases are usually observed in the neighboring glands. They are more common in carcinoma of the mandible than in the maxillæ. The lymph nodes infected are to be found in the cervical region (Figs. 747 and 748).

In carcinoma of the maxillæ, the parotid gland is often affected and in the mandible, the submaxillary and sublingual glands.

Usually cancer of the jaws presents a rapid clinical course. In a few

months from the time of its very first signs, the tumor may have outgrown the limits of a possible operation. Perthes mentions a case in the clinic at Leipzig in which the whole mandible became involved in seven weeks. The average duration of life from the time the first symptoms of carcinoma of the jaws appear is two years in non-operated cases.

Diagnosis.—In its first stages, the diagnosis of central carcinoma of the maxillæ may present some difficulties. Sudden "neuralgic" pain in the maxillary region, particularly in a person past middle age, accompanied by hemorrhage from one side of the nose, is suspicious. If the bone is found undergoing softening at any point, in addition to the foregoing signs, the diagnosis is much more certain. When a tumor is known to exist, but its character as to malignancy cannot be ascertained from the clinical data and symptoms present, an exploratory operation may be made and a piece of the tumor nipped off for a microscopical examination. H. Wolff has found this procedure valuable in two cases where his suspicions determined him to make an exploratory incision into the maxillary sinus before removing the bone for malignancy. Microscopical examination revealed that one case was simply an inflammatory form of tuberculosis. The other was a maxillary sinusitis with sequestrum formation. No malignant tumor was present in either case.

Carcinoma of the alveolar processes must be differentiated from tuberculosis and tertiary syphilitic swelling. Very seldom actinomycosis may be located in that region. A general examination of the body for evidences of tuberculosis or syphilis is advisable, though microscopical examination of an excised portion of the tumor will settle the problem in any case.

Prognosis.—In carcinoma of the jaws, the prognosis is even less hopeful than in sarcoma. Martens found that in his group of twenty cases the trouble returned in from one to thirty-eight months, or an average of nine to ten months. The trouble may return even after many years, following apparently successful operation.

Treatment.—Many surgeons of great repute declare that complete resection is the only recognized procedure and it must be undertaken as soon as the diagnosis is made; that even then it is often too late because of previous faulty diagnosis and the involvement of neighboring structures. Martens, in 1897, collected forty-nine cases from the literature and found that, among these, only two were cured. By this is meant that the patients survived at least three years following the operation, without renewal of the growth. When it is considered that these were cases operated upon by the very best surgeons, such as Braun, Birnbaum, Batzaroff, Küster, Ohlemann and von Petzo d, and that tumors have been known to recur even after considerably more than three years have elapsed, the hopelessness of the situation may be realized.

Stein's data concerning the cases of carcinoma of the maxillæ, operated upon at the Berlin clinic between 1890 and 1900, are no more encouraging.

Answers to inquiries concerning patients were received in thirteen instances, and in each the report was that the patient had died. Ten owed their death to a recurrence of the trouble and the other three died of general debility and cachexia within the first nine months following the operation. Similarly, not one of the twenty-three patients operated upon at the Breslau clinic between 1891 and 1901 remained free of the trouble for as long as three years following the operation. Contrasted with these data, the statistics of König's clinic at Göttinger, as reported by Martens, are very remarkable. Twenty-nine of forty-eight patients survived the operation for carcinoma of the maxillæ and eight of these showed no return of trouble

FIG. 749.—Central, solid, adamantine epithelioma of both halves of the upper jaw. Colored female, aged fifty-two years; tumor ten years. (*Bloodgood, Johns Hopkins Hospital collection in American Practice of Surgery.*)

for more than three years following excision of the bone. Of nine patients treated by partial resection, six died on account of recurrence. The remaining three had not been under observation for a sufficient length of time when the report was made.

No case of mandibular carcinoma is known to have been permanently cured or to have remained free of cancer for any considerable length of time following the operation. The case which Behm includes in his statistics as having remained cured for six years, Perthes believes to be one not of mandibular carcinoma, but, according to the clinical history of the patient, a case of multilocular cystoma of the mandible. The operative treatment is dealt with later, page 899.

FIG. 750.—Encapsulated fibrospindle-cell sarcoma of antrum. White male, aged twenty-five years. Tumor ten months; excision of upper jaw; patient has remained cured fourteen years. *T*, Tumor; *A*, antrum with alveolar border of jaw; *M*, molar tooth. (*Bloodgood, in American Practice of Surgery.*)

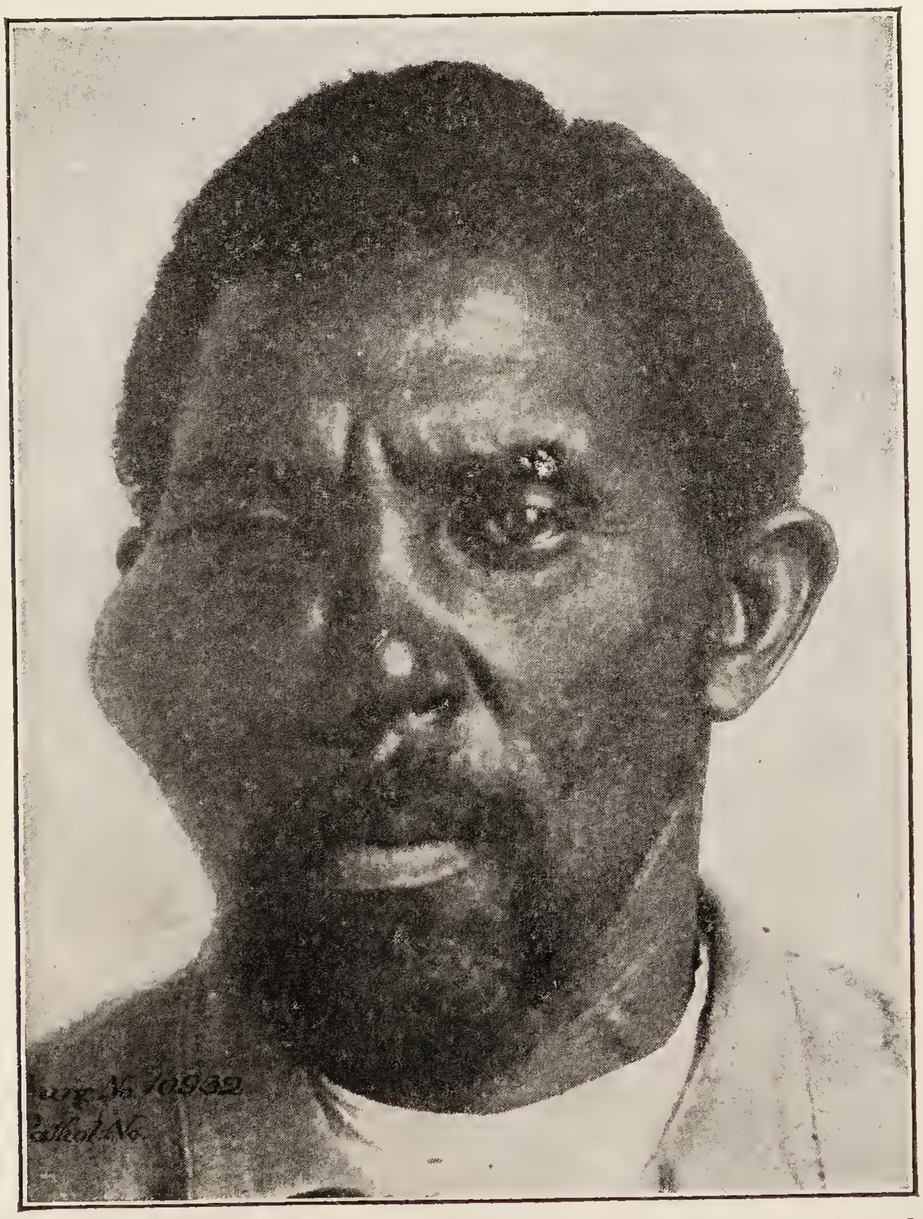


FIG. 751.—Inoperable sarcoma of upper jaw. Clinical diagnosis only. Colored male, aged fifty; pain and swelling of face. Five months; obstruction of, and hemorrhage from, right nares; bone capsule not preserved; infiltration of soft parts; bulging and fluctuation of palate. Death a few months after admission. (*Bloodgood, Johns Hopkins Hospital collection in American Practice of Surgery.*)

Sarcomata.—The histology of this tumor has been considered in the chapter on Tumors in general, page 98, therefore it is not considered here.

FIG. 752.—Cast of a sarcomatous epulis in a man fifty years old. Six month's duration. (*Dunning.*)

In reviewing the literature, I cannot do better than to quote from Bland-Sutton:

"Although it is customary to speak of sarcomas which are connected

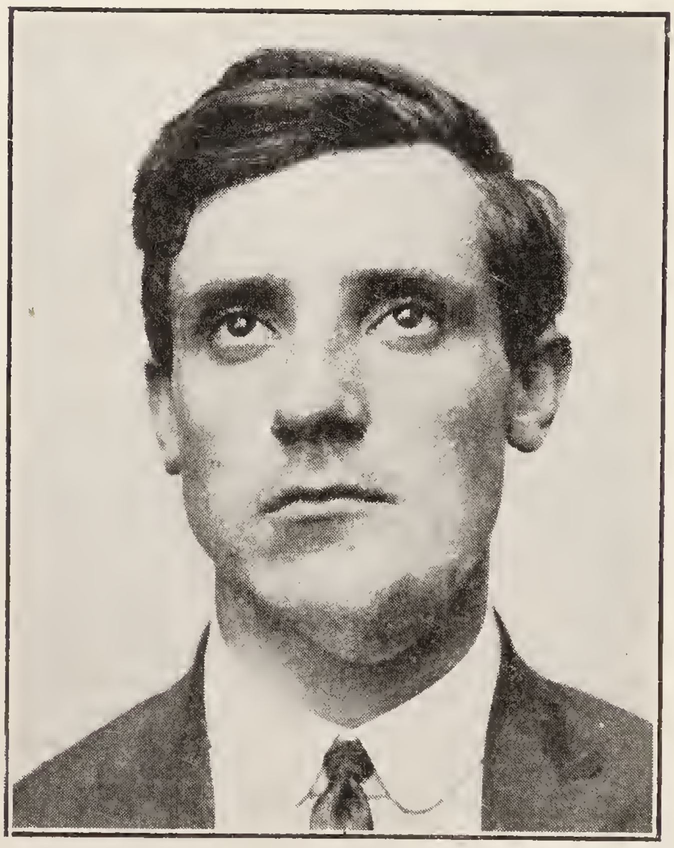


FIG. 753.—Congenital angioma of mandible becoming sarcomatous twenty-one years later. (*Oakman.*)

with the maxillæ and mandible clinically as tumors of the jaws, it would be erroneous to describe them indiscriminately as tumors of bone. In each jaw there are, in addition to the bone and periosteum, two structures to

consider—mucous membrane and teeth. In the case of the maxillæ, the antrum requires to be considered, with its gland-containing muco-periosteum.

Periosteal sarcomas of the jaws are rare before the fifteenth year, but they may occur at any age, even in infants. They belong to the round- and spindle-celled species and grow very rapidly. These tumors are less frequent on the mandible than the maxillæ; they grow from any part of it. Those which spring from the outer surface of the ramus are apt to be mistaken for parotid tumors.

Fig. 754.—Medullary giant-cell sarcoma arising in symphysis of lower jaw. Photograph of gross specimen. White female, aged twenty-one years. Tumor ten months; patient has remained cured nine years. (*Bloodgood, Johns Hopkins Hospital collection in American Practice of Surgery.*)

Periosteal sarcomas originate in any part of the maxillæ (Figs. 750 and 751) but they rarely arise from its facial surface and, though fairly frequent on the gums (Fig. 752), are very rare in connection with the mucous membrane of the palatine process. The muco-periosteum of the antrum is a common situation for these tumors and, as they grow, they cause thinning and expansion of the walls of this chamber. This enlargement of the body of the maxilla causes it to encroach on the nasal fossa and obstruct respiration;

FIG. 755.—Periosteal round-cell sarcoma of lower jaw. White male, aged forty-nine. Symptoms of onset: loose teeth eleven months; two weeks later, swelling. Extraction of teeth relieved neither swelling nor pain; exploratory incision by dentist was followed by more rapid growth. The very cellular new growth surrounds the body and ramus of jaw. Rapid local recurrence and death. (*Bloodgood, in American Practice of Surgery.*)

FIG. 756.

FIG. 757.

FIG. 756.—Periosteal osteosarcoma of lower jaw. Colored girl aged twenty-four years. Pain three years; swelling of jaw three and one-half months. Resection; patient has remained cured eleven years. (*Bloodgood, Johns Hopkins Hospital collection in American Practice of Surgery.*)

FIG. 757.—Extensive epulis which was removed intra-orally.

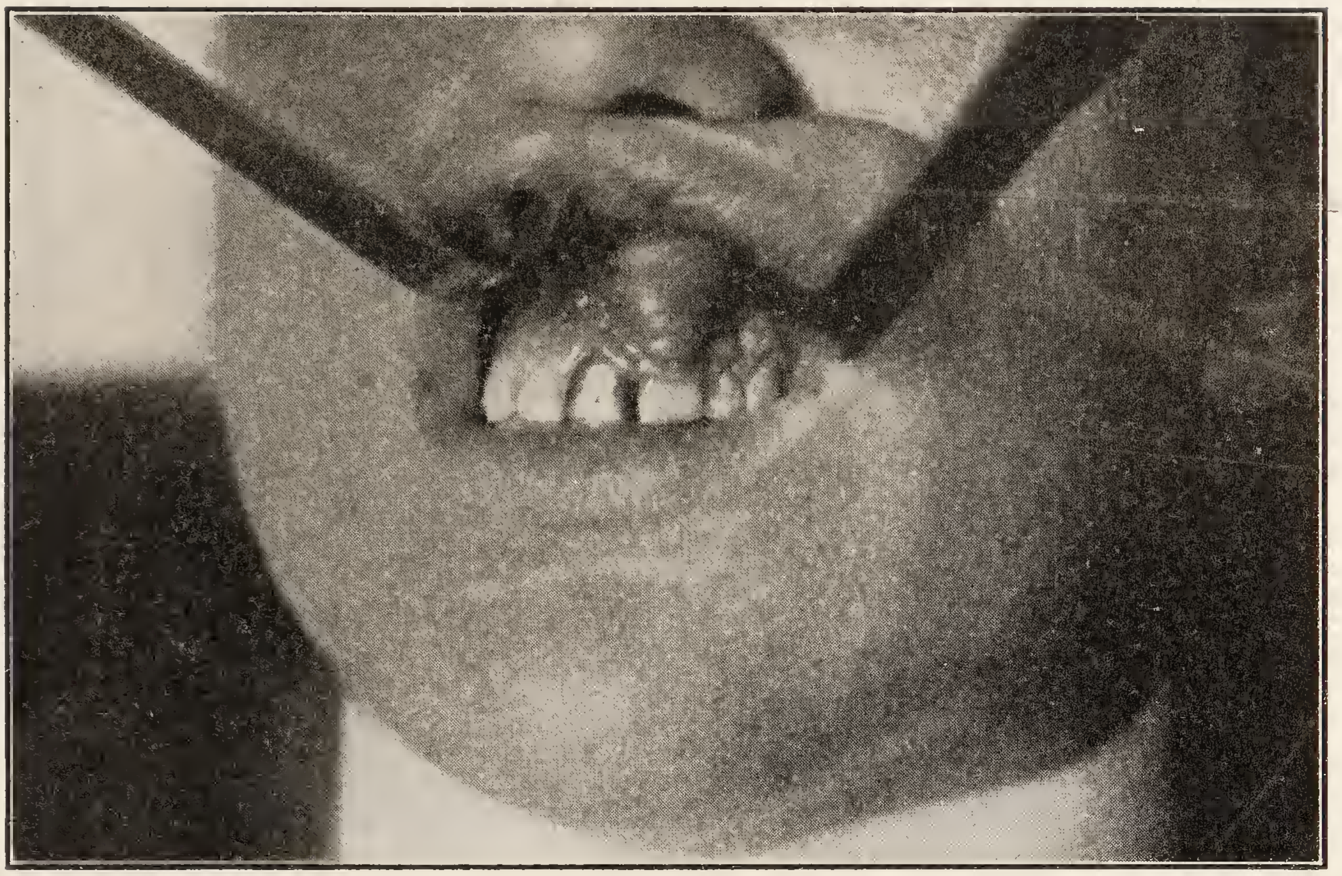


FIG. 758.—Fibroma of eight months' duration in a patient twenty-one years of age due to irritation of gold crown and porcelain crown attached thereto. It extended to floor of nose and did not recur. (*Dunning.*)

FIG. 759.—Epulis occurring in a child eleven years old. The growth was removed without recurrence.

often the tumor pushes up the orbital plate and displaces the eyeball (proptosis), and in a certain proportion of cases the alveolar border is depressed.

FIG. 760.—Epulis completely covering the teeth.

The nasal duct is frequently implicated, and when it is completely obstructed epiphora is the consequence. Clinically, a sarcoma originating within the

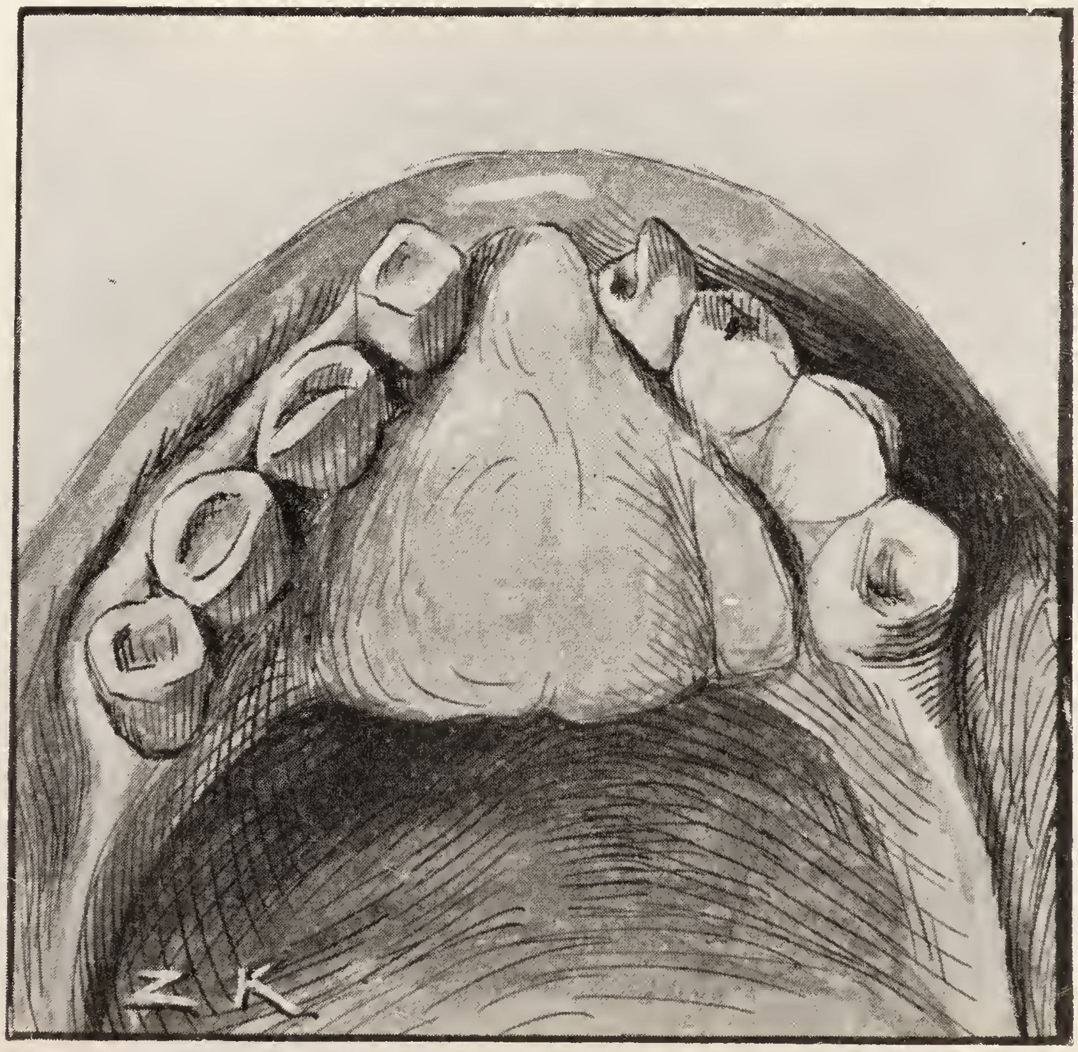


FIG. 761.—Plaster cast showing an epulis of the mandible which caused a separation of the teeth. Removed without recurrence.

antrum expands its walls and, by degrees, processes of the tumor make their way through and implicate the skin of the cheek or, projecting into

the nasal fossa, ulcerate and give rise to frequently recurring hemorrhage. When the tumor perforates the posterior wall of the antrum, it will enter the zygomatic and spheno-maxillary fossæ and creep thence into the temporal

FIG. 762.—Plaster cast of an epulis between the central incisor teeth.

fossa, or make its way through the spheno-maxillary fissure and ramify in the orbit, or steal through the sphenoidal fissure or foramen rotundum into the middle fossa of the cranium.

FIG. 763.—Fibrous tumor located in the posterior wall of the left pharynx.

The mucous membrane of the hard and soft palate is liable to malignant tumors belonging to the sarcomas and squamous-celled carcinomas. It is

also liable to a peculiar tumor, which is somewhat rare, named 'adenoma of the palate.' These tumors are usually ovoid in shape and vary in size from a cob-nut to a hen's egg; they occur more frequently in the soft than in the hard palate and are invariably encapsuled. These 'palatine adenomas' are complex in structure. Some possess glandular tissue with ill-formed ducts and acini which, in their structure, mimic cancer, whilst the stroma in which

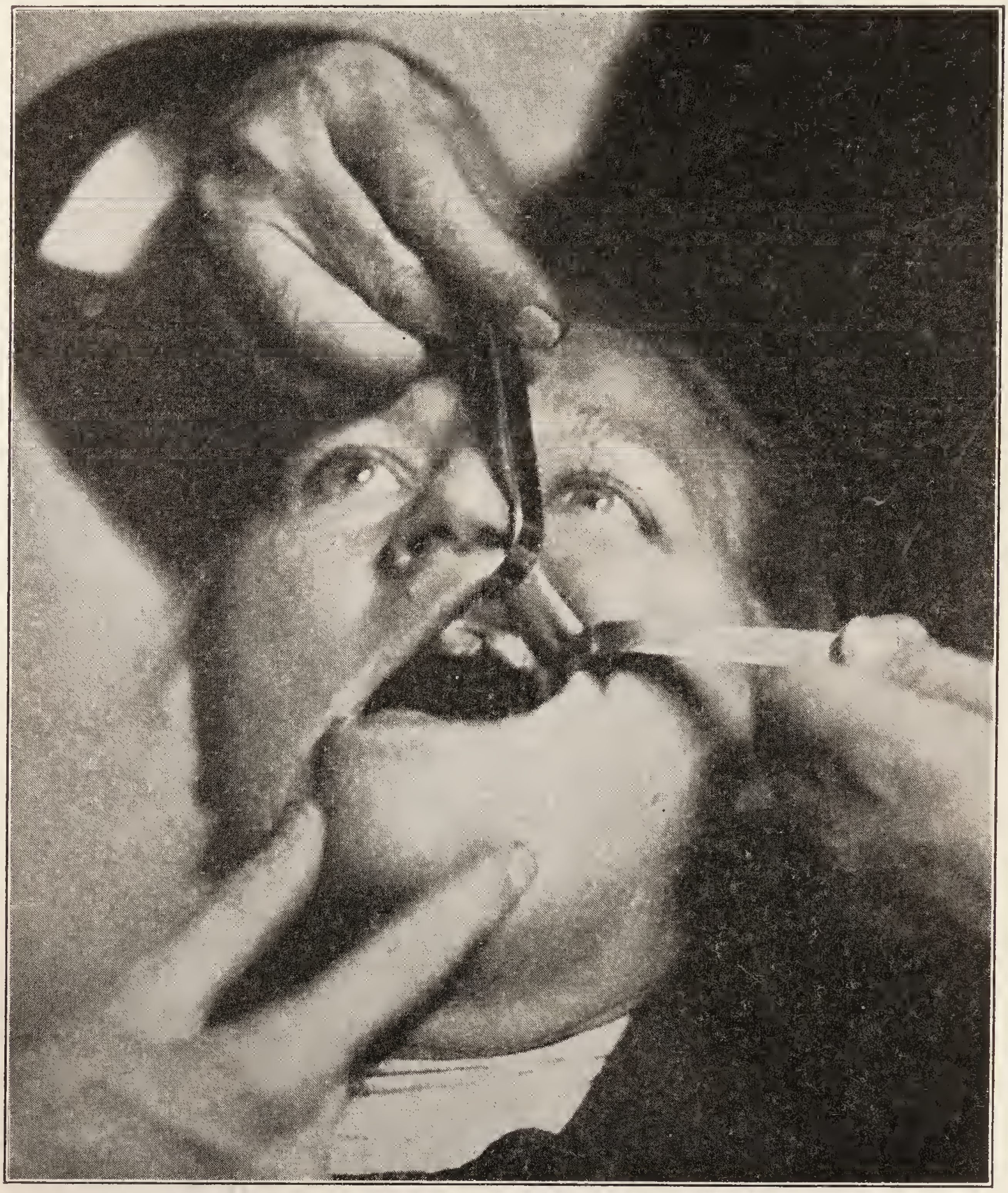


FIG. 764.—Epulis.

they are embedded imitates sarcomatous tissue. They occur most strongly between the thirtieth and fiftieth years, but they have been met with at puberty. They are innocent tumors. They have been carefully studied by Stephen Paget and Hutchinson, Junior. Many tumors described as sarcomas of the jaws are endotheliomas."

Sarcoma of the mandible is seen less frequently than that of the maxillæ. When sarcoma occurs in the mandible, it is usually associated with an

osteoma or the two may be thoroughly interwoven and be an osteosarcoma. The origin and development of these tumors are the same as those in the maxillæ. Fig. 753 illustrates a case of congenital angioma of the mandible which became sarcomatous. I am indebted to Bloodgood for three illustrations showing sarcomas of the lower jaw (Figs. 754 to 756).

Epulis.—Its name implies a tumor upon the gum. It seems to be on the gums, yet, in tracing the growth, it is found to originate from the periosteum, usually at the border of the dento-alveolar process. As it develops it involves the gum-tissue (Fig. 757). Very frequently it causes a wide separation of the teeth (Fig. 761). It is a growth which occurs most frequently anterior to the molar teeth.

Fig. 765.—After operation.

It is occasionally seen in children eight years of age or older (Fig. 759) and in adults, though not common after the fiftieth year. It is found with equal frequency in both sexes.

There are two forms of epulis: one fibrous and firm, the other highly vascular and erectile, often termed myeloid. Hemorrhage occurs in the latter on the slightest friction. An epulic tumor closely simulates hypertrophy of the gums which is very often seen in pregnancy. A differential diagnosis is essential in these cases as the treatment varies in each. The rapid growth of the vascular epulis is noteworthy. In forty-eight hours a growth which has only been pared away will recur. Growing toward the edges of the teeth, it often completely obscures them from view (Fig. 760).

Fig. 766.—Small round-cell sarcoma of eight months' duration in a boy twelve years of age. It started as epulis around first molar, which was removed, and recurred after about six weeks. (*Dunning.*)

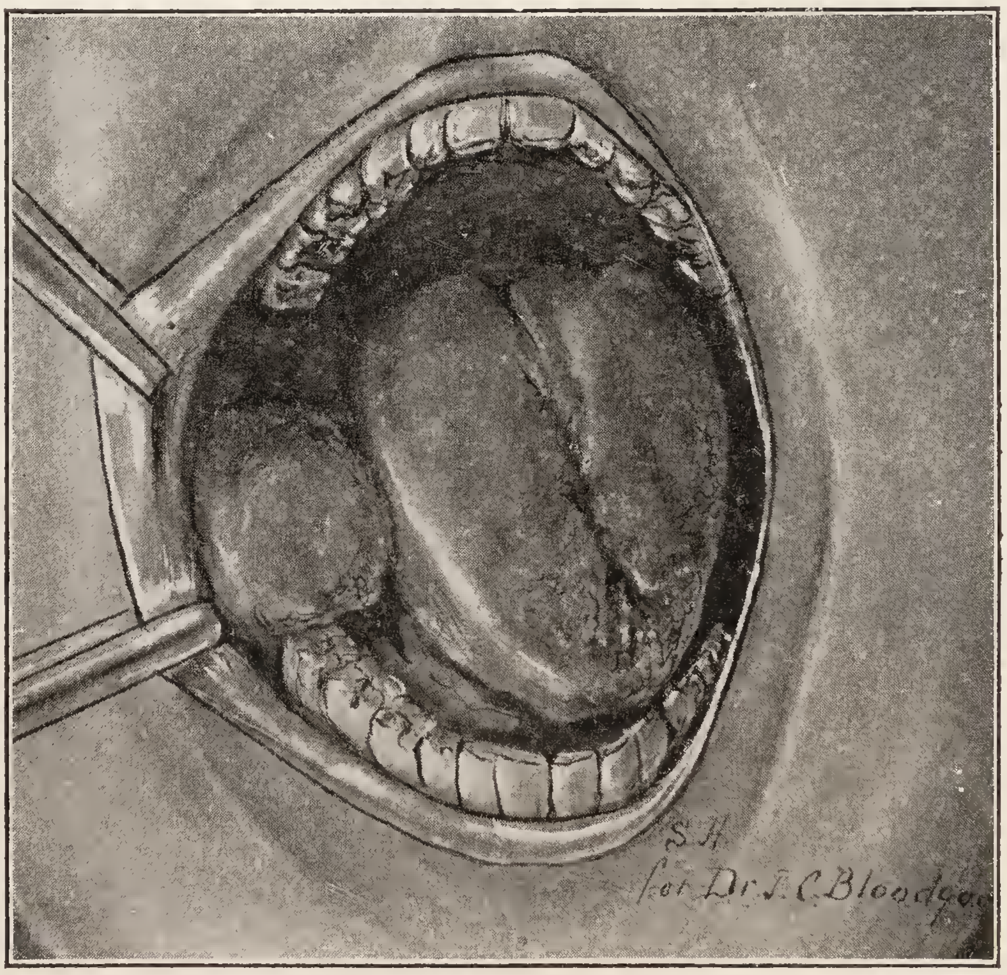


Fig. 767.—Giant-cell epulis of lower jaw; painless growth three years in white male, aged fifty. The last two molars have been lost, after the appearance of the tumor. (*Bloodgood, in American Practice of Surgery.*)

Epulis is the most common oral tumor. It may be found often in the mouths of those who are careless in the care of the teeth. It arises more

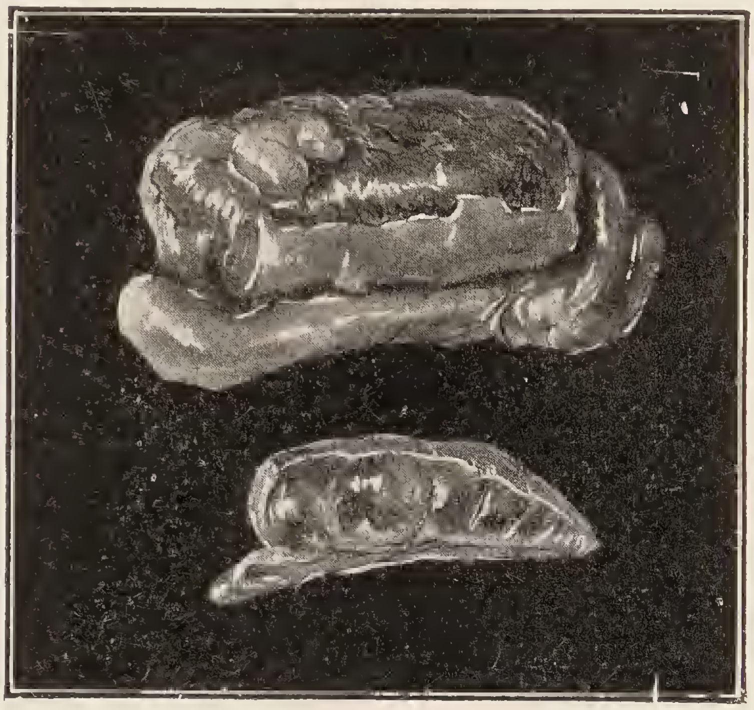


FIG. 768.—Fresh specimen showing section and surface of tumor illustrated in Fig. 767. Giant-cell epulis. (*Bloodgood, in American Practice of Surgery.*)

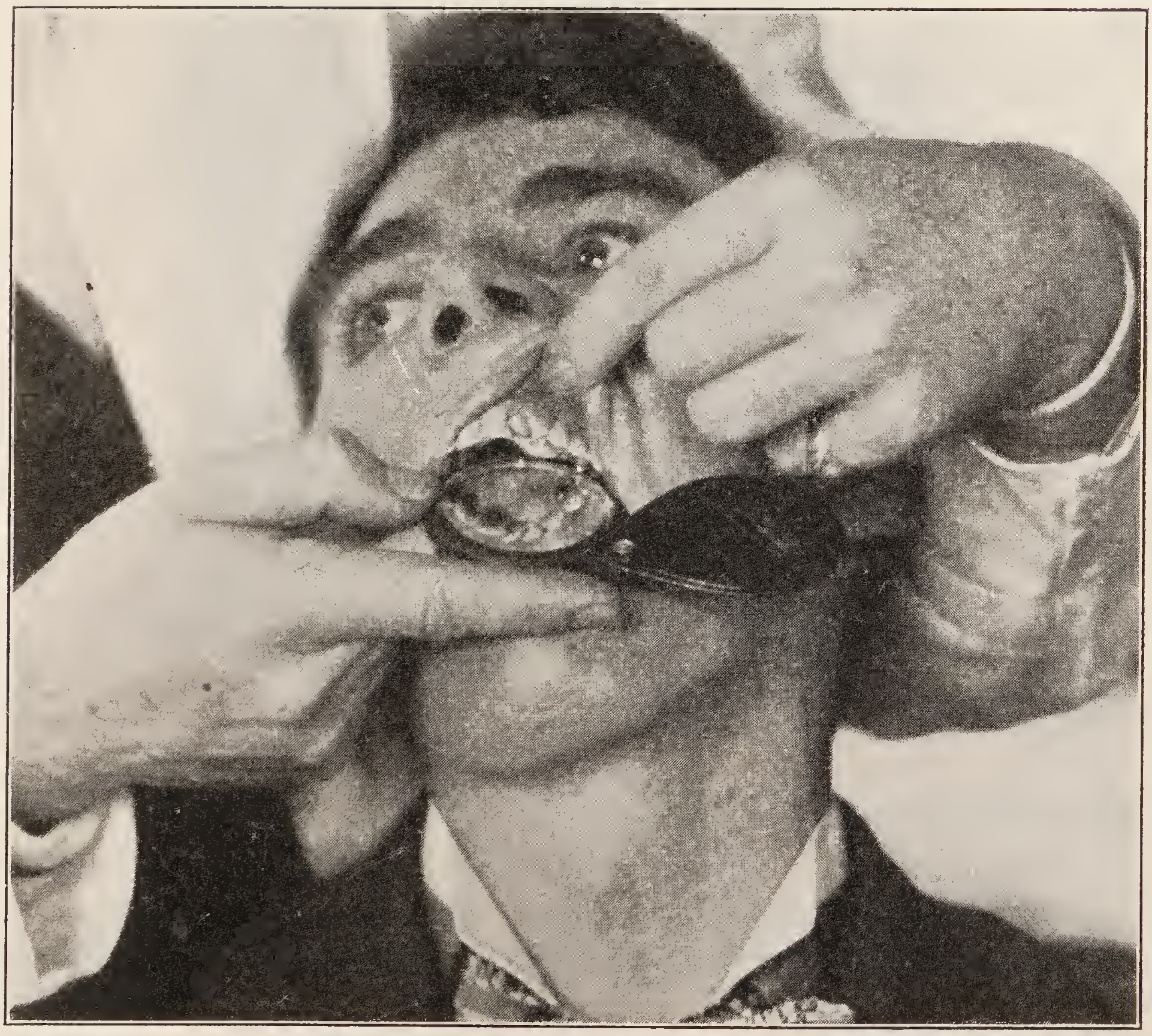


FIG. 768*a*.—Incipient osteofibroma of the maxilla.

frequently as a result of the formation of salivary calculus upon the necks of the teeth. These may extend up as far as the alveolar border and cause

an irritation of the periosteum, thus establishing the initial lesion of the growth. An epulis is a benign tumor primarily, but, being subject to continuous irritation, it may become malignant, taking on the form of a sarcoma or osteo-sarcoma (Fig. 766).

Treatment.—It should be removed in its incipiency. There is, perhaps, no class of tumors treated with so little success since the operator too frequently removes only the growth as it appears on the gums. This is an error, based upon a misunderstanding of its true pathology. To remove such a growth without completely removing all the cells from which it originates

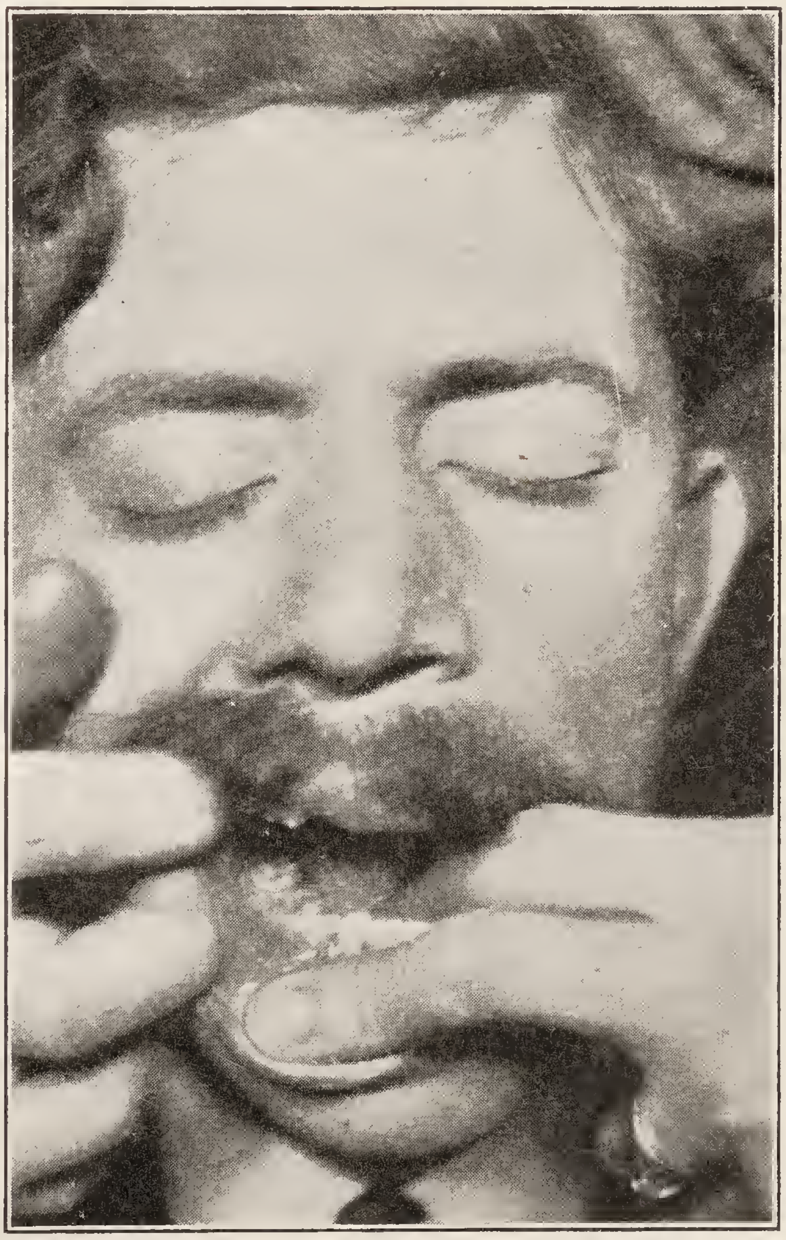


FIG. 769.—Extensive osteofibroma of the mandible.

is sure to prove a failure. It is necessary to cut down to the bone, removing the periosteum and some of the bone as well. By so doing, the tumor with its base will be removed. It so happens sometimes that the pericementum of one or more teeth may be involved in the growth. In this event, their complete removal, together with the corresponding alveoli, is indicated.

After the removal of the tumor with the periosteum and bone, the cavity should be packed with gauze from time to time, thus stimulating granulation.

In pregnant women it is not an uncommon error to operate an hypertrophy of the gums which has been mistaken for epulis. During the period

of gestation, the whole organism seems to be endowed with a tendency toward the multiplication of cells, so the gums respond under irritation. The gums bleed easily, which causes the patient to refrain from cleansing the teeth and mouth. After delivery, hypertrophy of the gums usually subsides quickly without treatment. It is advisable to exercise greater diligence in cleansing the teeth and mouth. Tannic acid and glycerin (10 grains to the ounce) may be used advantageously to contract the engorged capillaries and arrest the hemorrhage.

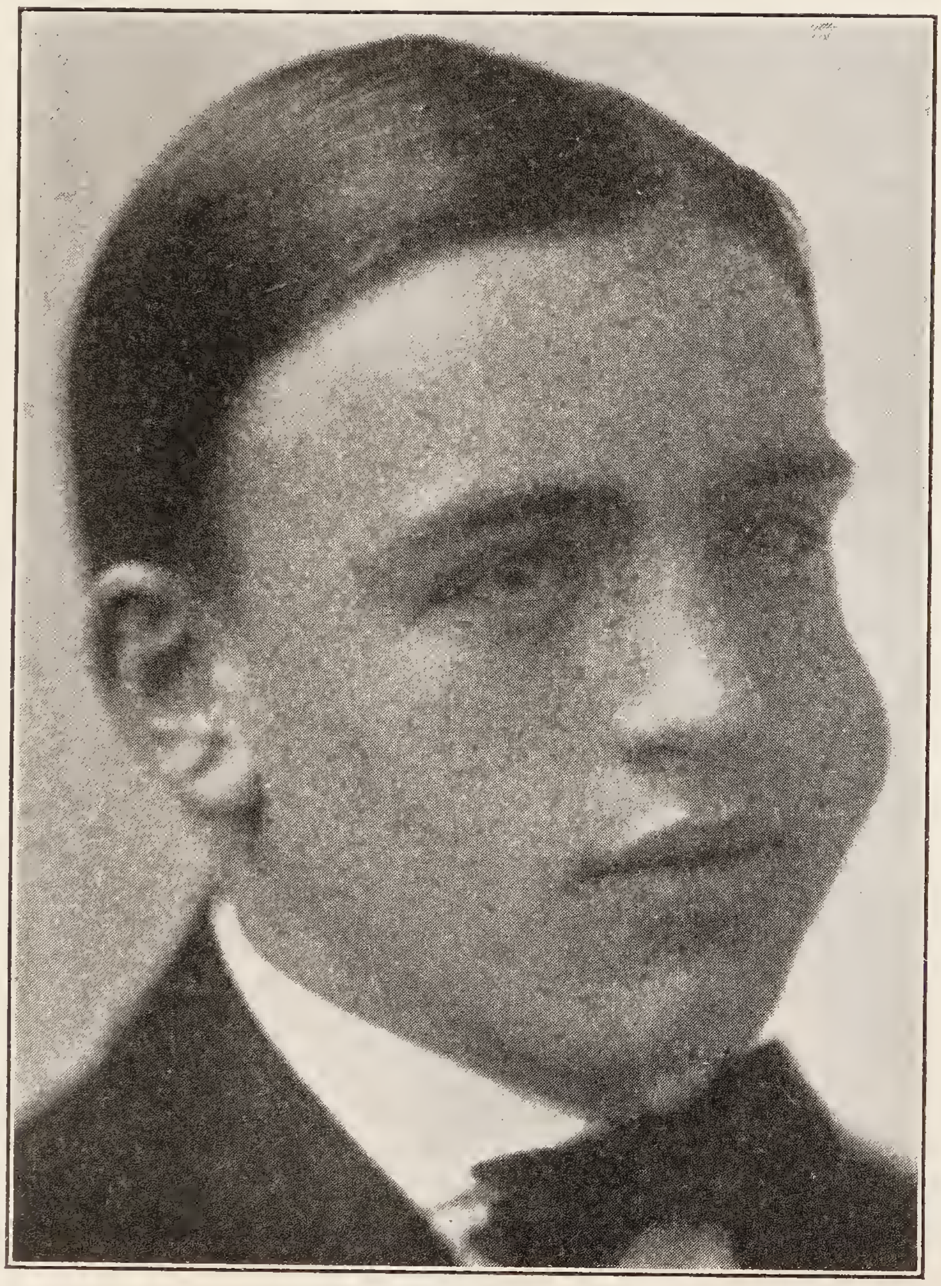


FIG. 770.—Fibroma of the cheek which was removed intra-orally. Before operation.

LIGATION OF THE EXTERNAL CAROTID ARTERY PRELIMINARY TO RESECTION OF THE MANDIBLE

Any measure capable of decreasing hemorrhage would thereby decrease the danger of asphyxia or post-operative pneumonia. With this aim in view, Lesser in 1882, and before him Reyher and Weljaminow, carried out a preliminary ligation of the common carotid in cases of upper jaw resections. The practice, however, never gained in favor because of the danger which ligation of the common carotid presents. Zimmerman and Reis found that as many as one-fourth of the patients afterwards showed

serious affections of the brain, such as softening and paralysis. Kocher states that the ligation of the common carotid artery in an old person with arteriosclerosis is practically a death sentence.

The practice of compressing or ligating temporarily one or both external carotids during the operation is not open to such objections (Fig. 773). This must not be done, however, in patients with advanced arteriosclerosis.

On the other hand, simple prophylactic ligation of the external carotid,

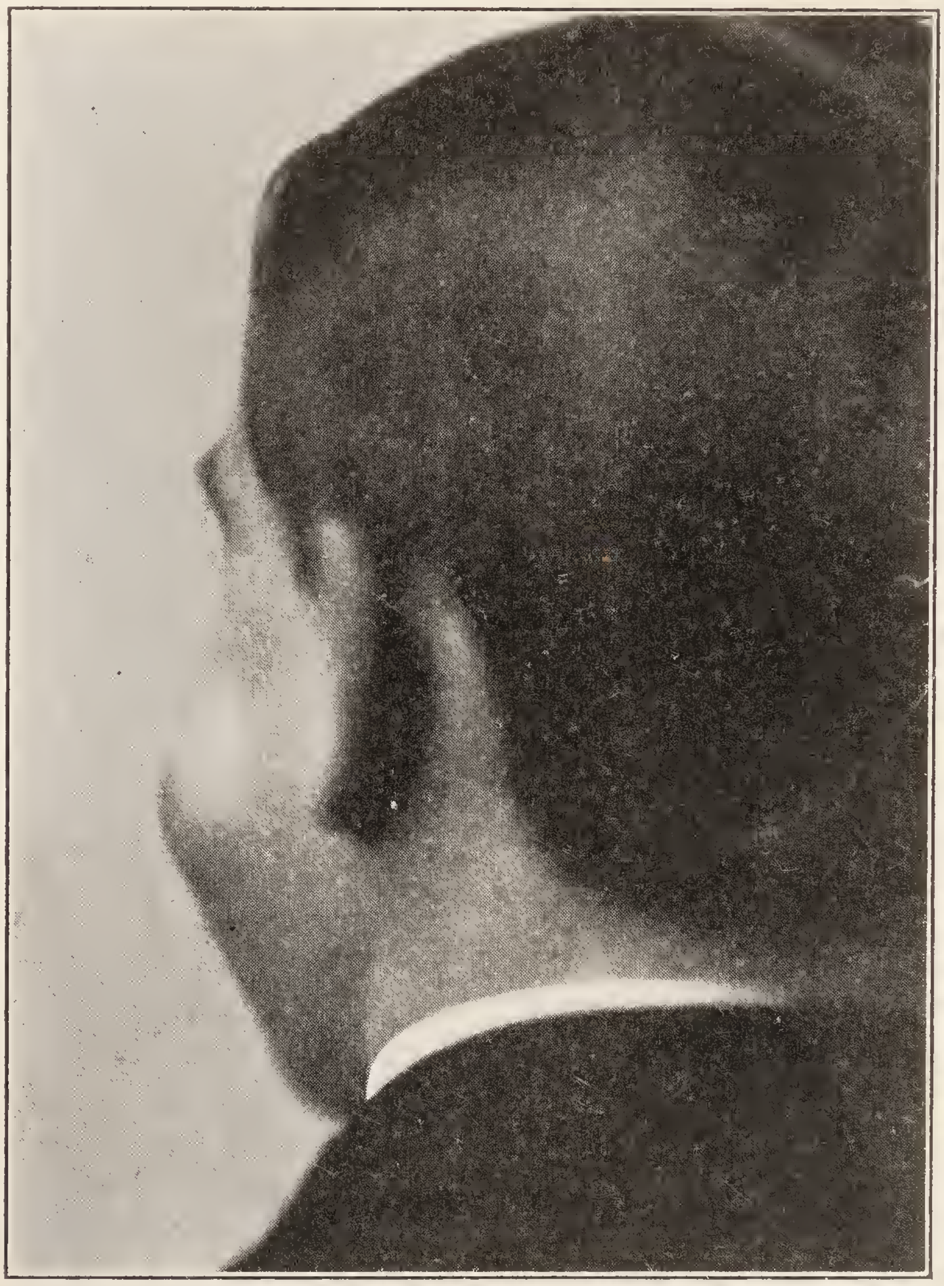


Fig. 771.—Before operation.

as practised first in 1891 by Bryant and later recommended by Kocher, König, Schlatter and others, is the safest procedure.

The external carotid is easily and safely ligated (see p. 1025), and this preliminary operation presents no danger of thrombosis if carried out at a distant point from its bifurcation. It is, of course, far better and equally safe to carry out the ligation of the external carotid on both sides.

The careful researches of Madelburg, Lipps and others have established that the saving in hemorrhage is very considerable. The field of operation is not bloodless, of course, inasmuch as anastomoses are frequent with the internal and branches of the opposite external carotid, but the bleeding is

lessened sufficiently to make the preliminary ligation of the external carotid, at least on the affected side, a highly desirable procedure.

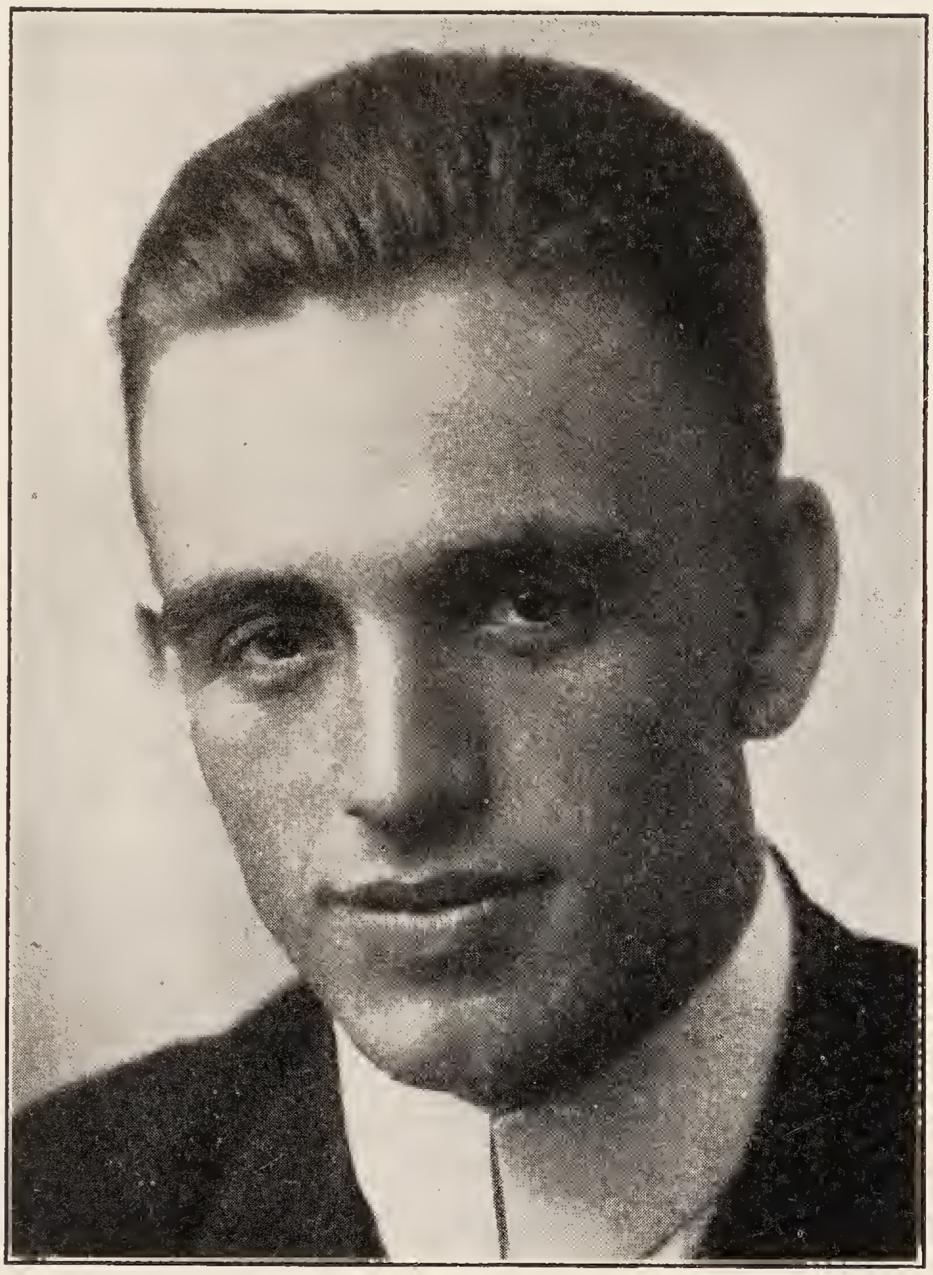


FIG. 772.—After operation.

This is illustrated, for instance, in such a case as the one reported by Seidel, in which the maxillæ were resected. The external carotid was

FIG. 773.—Digital compression of carotid artery. (*Marwedel.*)

ligated first on one side, but not on the other. The result was that while the operation proceeded swiftly on the former, on the latter side it was

frequently interrupted by considerable hemorrhages from the arteries, necessitating numerous ligations.

As to the point of ligation, König, Junior, prefers to apply the ligature on the stem of the external carotid between the superior thyroid and the lingual branches rather than near its base. This is also recommended by Stein, who has studied the subject in v. Bergmann's clinic. Ligation at this point prevents the establishment of collateral circulation in the external carotid regions by the anastomosis of branches from the superior and the inferior thyroid. Bryant, who conceived this preliminary operation, recommends bilateral ligation.

Incidentally, with the ligation of the external carotids, a number of lymph glands are exposed along its course and these may be removed if they show signs of swelling or metastatic infection.

Position of the Patient.—In this operation the position of the patient is very important. The usual horizontal position is permitted only during the preliminary external incisions, but with the opening of the oral cavity, the patient's position must be changed so as not to favor the aspiration of blood.

Most surgeons place their patient in a recumbent or upright position while assistants hold his head a little forward, so that the blood escaping when the bone is severed may flow outward instead of into the larynx. This position is particularly desired for patients under semi-narcosis.

Other surgeons prefer the plan suggested by Rose in 1874 of allowing the patient's head to hang low over the edge of the table. With this position the patient must be completely anesthetized before the operation is commenced. The extreme hyper-extension of the head, which is held downward almost at right angles to the body, permits the blood that escapes to flow out through the mouth and nostrils. The soft parts may be incised first, with the patient in the ordinary horizontal position, and then his head may be brought down for the excision of the bone proper, although Rose did not hesitate to hold the patient's head in this position from the first and until the operation was completed.

The great disadvantage of this position is the fact that it favors passive congestion of the field of operation and increases the hemorrhage to such an extent that experienced surgeons, such as Batzaroff, Bubrik, Müller and others, have abandoned it after a trial. So great is the congestion that the patient's entire head and face become discolored and swollen.

Ligation of the external carotids does not do away with the chief objection to this position of the head, because the congestion and hemorrhage which it causes are chiefly venous. The plan has been suggested by Stein and carried out by König, Junior.

Protection of the Air Passages by Tampon-canule and Intubation.—The tamponing of the trachea, devised by Trendelenburg for the protection of the air passages against the inflow of blood, has never won the pro-

fession's approval and may be mentioned now only as a historical fact. On the other hand, preliminary tracheotomy and intubation, also proposed by Trendelenburg, may be considered, according to Perthes, to be on trial as yet.

Both he and Nussbaum have proposed, at about the same time, though independently of each other, the application of compresses above the tracheotomy tube so as to prevent any blood from trickling down. The anesthetic is administered through the tracheotomy tube. This plan was suggested in 1869 and, as early as 1874, surgeons discovered very serious objections to it. Above all, tracheotomy, in itself, is a very serious complication to bring upon the patient at the time of operation when his strength is so heavily taxed otherwise. Besides, it may, in itself, be the cause of very unpleasant complications, such as inflammation of the trachea, due to the pressure of the tube, and bronchitis. The tracheotomized patient endures great tortures because of his inability to expel the mucus and saliva gathering in the back of his throat. What is more, the danger of pneumonia is increased by the preliminary tracheotomy.

The latest statistics on the subject are those given by v. Bergmann, covering the years 1890–1900. They show that, out of fourteen patients in which preliminary tracheotomy was carried out, five died, and four of these on account of broncho-pneumonia, while, out of the thirty-three cases of total resection of the jaw without preliminary tracheotomy, only two died, one of erysipelas. (In the other no post-mortem examination was held.)

Preliminary tracheotomy has been abandoned by most surgeons, including the discoverer of the method. Instead of tracheotomy, various surgeons have attempted to obtain the same results by a simpler device, such as catheterization or intubation of the larynx. Rabe conceived this idea in 1873. Improvements on it have been made by Eisenmenger in 1893, O. Dwyer, the inventor of intubation, in 1894, Stockum in 1898, Kuhn in 1901 and by Schlechtendahl in 1902.

Perthes maintains that Kuhn's device is the best and this also appears from Dirk's study of it. At the surgical congress in 1905, Rutter performed a complete resection of the upper jaw on a patient, who was anesthetized through Kuhn's oral tube, to demonstrate how the progress of the operation is not interfered with by the presence of the tube passing into the trachea.

In 1906 Dirk reported on seven operations under intra-oral intubation narcosis; three of these cases were resections of the upper jaw.

After operation by this method, patients remain singularly free of pulmonary or tracheal symptoms of irritation. The value of this method, for the prevention of the greatest post-operative danger, remains to be proven.

When circumstances arise calling for tracheotomy, the patient should be placed on his back with the shoulders raised and the head thrown backward. No time is to be lost in performing the operation if edema of the

glottis or a foreign substance has interrupted the respiration. The knife should be thrust into the trachea. The incision starts below the thyroid cartilage in the middle line. It is carried downward about one and a half inches. Immediately, the parts should be retracted by two suitable retractors so as to favor the easy ingress of air. We are acting in an emergency in carrying out the above operation and we cannot, therefore, take into consideration the technic usually employed when haste is not demanded. If necessity does not call for rapidity, the skin may be incised and the trachea approached more deliberately. All bleeding vessels should then be ligated and the trachea opened into. A hemostatic forceps should be introduced into the trachea and the wound edges separated so as to enable the operator to introduce a tracheotomy tube. It is made of silver and consists of two pieces, an inner and an outer tube (Fig. 774). The tube is kept in place by passing tape around the neck and fastening it to the holes in the outer cannula.

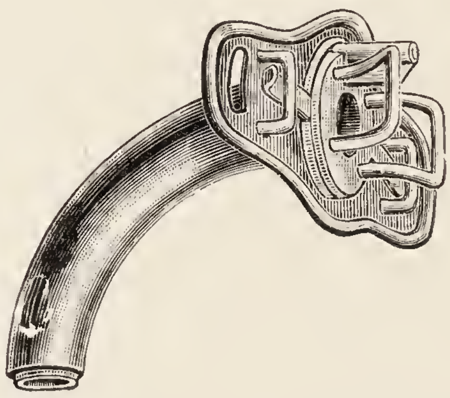


FIG. 774.—Tracheal tube, Luer's, made in six sizes of aluminum.

It is very important to remove the inner tube frequently and cleanse it to prevent infection of the upper air passages and to allow air to pass freely. A thin screen of fine gauze should be placed over the opening to prevent dust from entering the trachea.

Disinfection and Asepsis.—In all oral operations, the mouth must be cleaned thoroughly. For some time before the operation, the patient should be directed to use frequent mouth washes. Carious teeth must be filled or extracted, especially before upper jaw resection, and the oral toilette should be thorough whenever presence of an ulcerating carcinoma does not render this impossible. Even in the most helpless cases, thorough cleanliness should be insisted upon.

RESECTION OF THE MANDIBLE AND THE MAXILLÆ

Indications for Removal.—Diseases which invade the mandible and the maxillæ and call for their resection, in whole or in part, are the following:

1. A tumor involving the bone, such as osteoma, sarcoma, carcinoma and mixed tumors. These growths may be limited to a certain area of the bone or involve the greater part or whole. On examination of the mandible,

the growths apparently develop in certain locations. On close observation with the aid of a Röntgen photograph, their nature and extent may be determined. An odontoma leads to a solution of the bone with absorption of its substance. It may be easily mistaken for a bony tumor. The removal of the bone in the treatment of such a growth is a great mistake. Osseous growths are sometimes limited to a certain area of the bone though completely surrounding it. Whether to remove the entire bone or the diseased portion is to be determined by a careful diagnosis.

The practice of removing the entire mandible in the treatment of all carci-

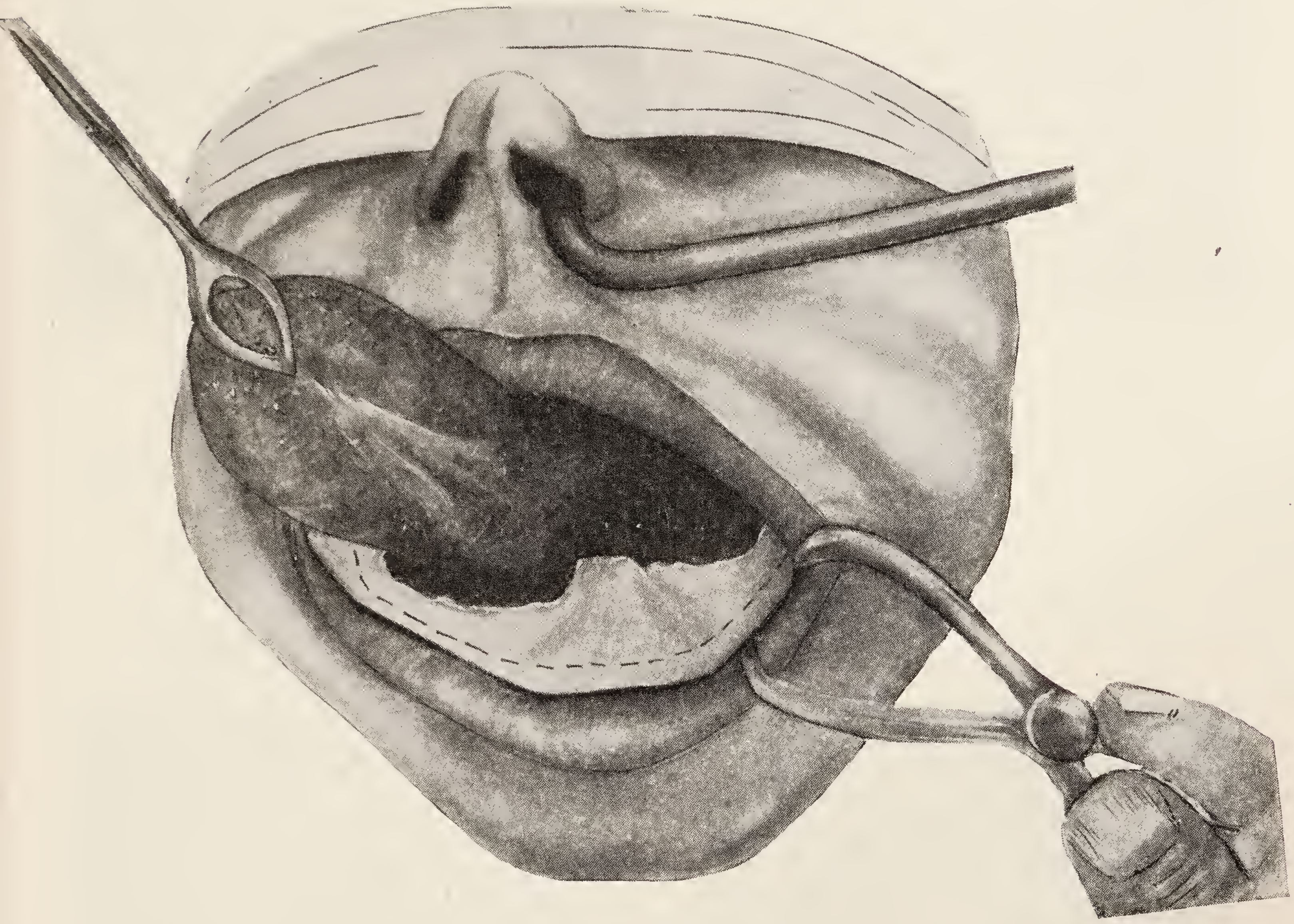


Fig. 775.—Showing the method of removing the mandible intra-orally for carcinoma of the alveolar processes together with the soft parts. A thin layer of the lower border of the bone was left as indicated by the dotted lines.

noma is uncalled for. I realize that many surgeons of wide repute are of the opinion that carcinoma of the mandible calls for its complete removal, but experience in the management of such patients convinces me that resection of the entire mandible is a mistake. Should a carcinoma appear on one side, involving the submaxillary gland, the floor of the mouth and one-half of the tongue, the diseased tissue should be removed, together with some of the normal tissue beyond. An artificial substitute may be adjusted to take the place of the lost bone.

The extent of the disease will guide the operator in resecting the mandible. It is true that it becomes necessary sometimes to disarticulate and remove

FIG. 776.

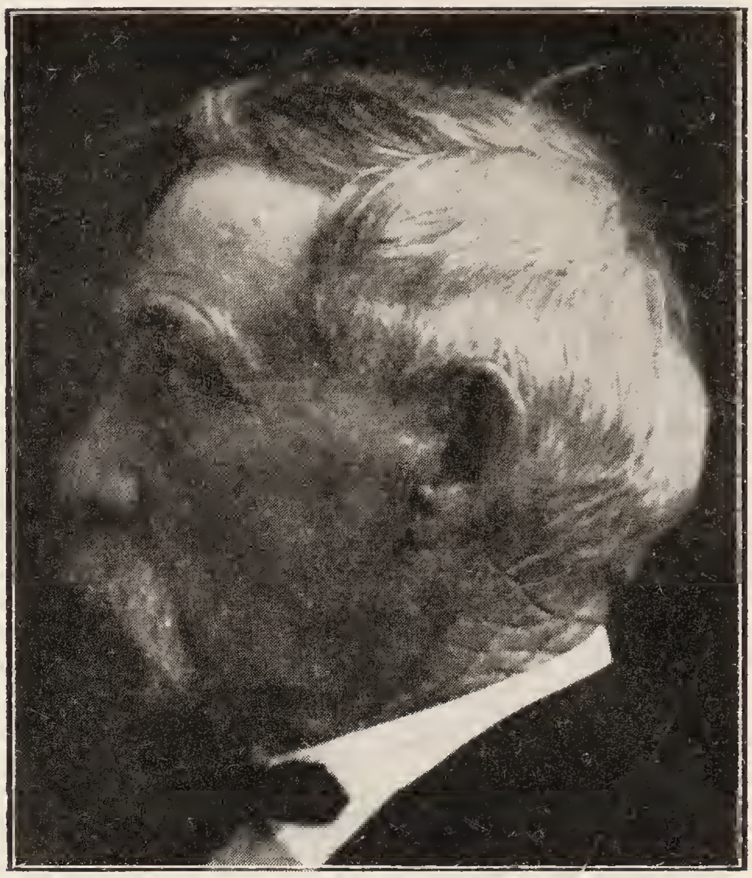


FIG. 777.

FIG. 776.—Patient showing condition of lower jaw five years after operating as depicted in Fig. 775. No recurrence.

FIG. 777.—Shows the occlusion of the teeth following the removal of a section of the mandible extending from the cuspid tooth to the glenoid fossa. No external incision was made.

FIG. 778.—Shows a front view of the patient in repose.

FIG. 779.—Profile view of side from which the bone was removed.

FIG. 780.

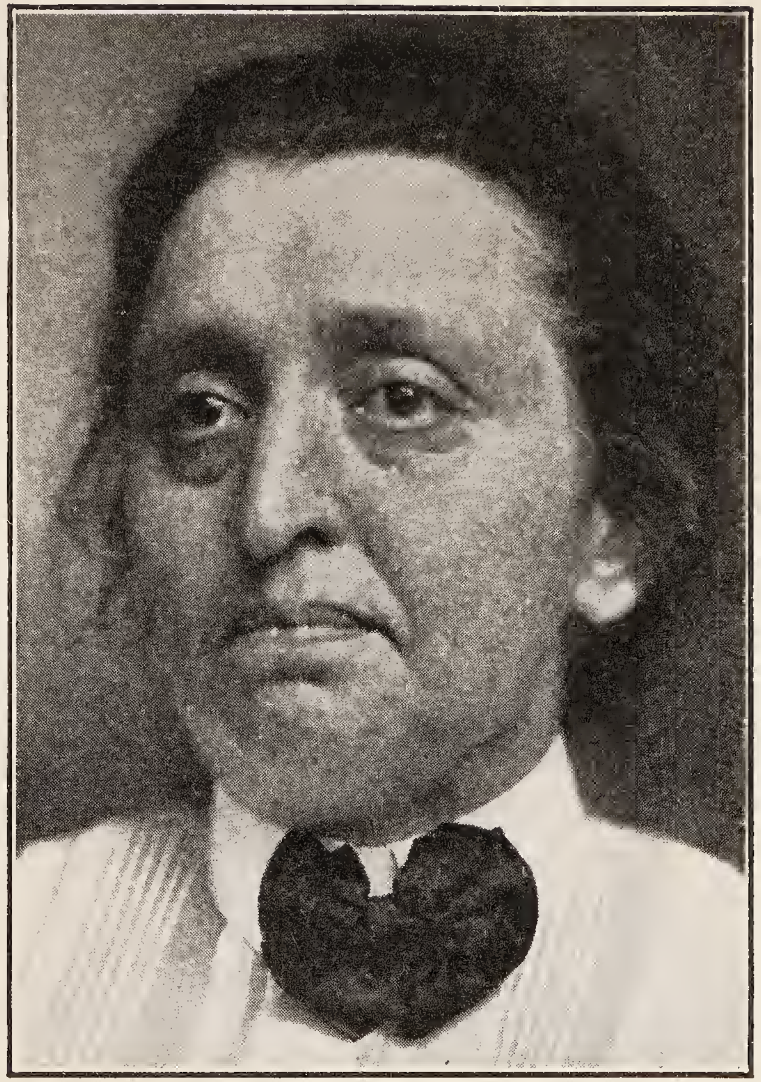


FIG. 781.

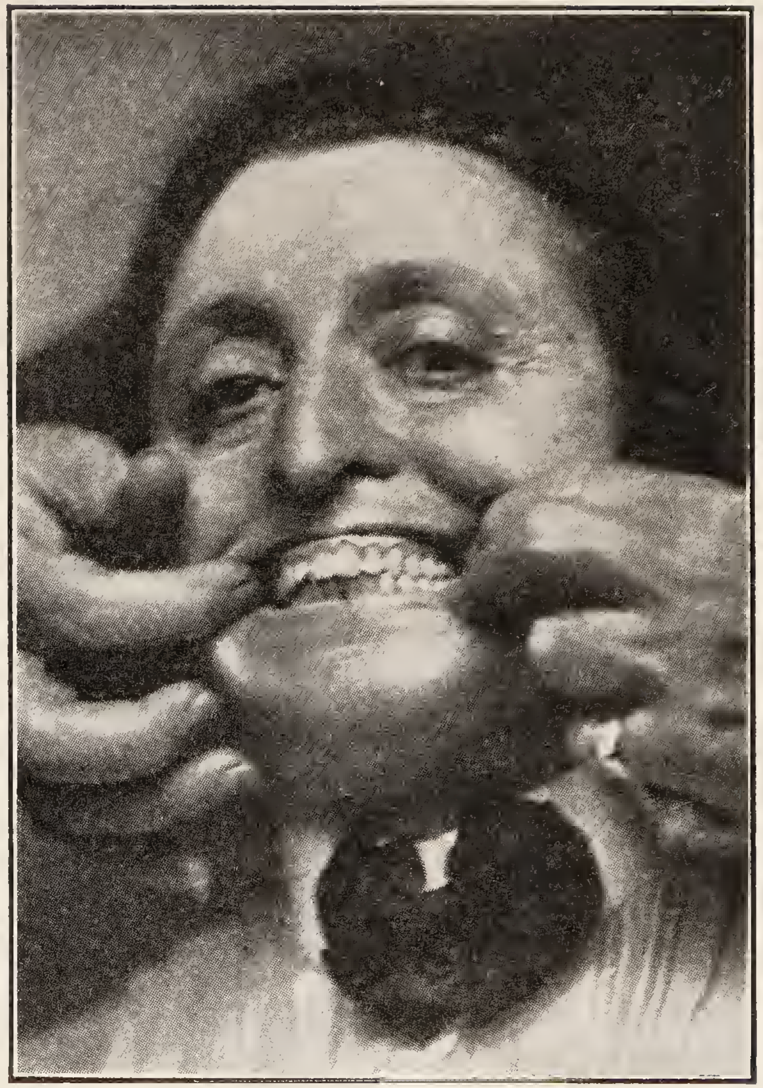


FIG. 782.

FIGS. 780, 781 and 782.—Necrosis of the mandible following an osteomyelitis which necessitated the removal of the posterior third of the body and a portion of the ramus. The operation was performed intra-orally. The teeth were retained in normal occlusion by wiring the upper to the lower ones until cicatrization was completed. The occlusion of the teeth is perfectly preserved.

the entire mandible. On the other hand, sometimes all that is required is to remove a large section of the dento-alveolar process and allow a bridge of bone to remain along the lower border sufficiently strong to serve as a means of preserving the normal contour of the face (Figs. 775 and 776). The great deformity following the removal of a section of the mandible without adjusting prosthesis is very conspicuous. It needs only the removal of a small section to distort the features.

2. In addition to tumors, caries and necrosis of bone from various causes call for resection (Figs. 777 to 779). Necrosis may be due to scarlet fever, typhoid fever, tooth infections, phosphorus, mercury, arsenic poisoning, etc. The loss of the vitality of the bone from phosphorus poisoning may call for the removal of part or all of the bone.

3. As a sequel of compound fracture, large sections of the bone are sometimes lost. Diseases which call for the removal of the mandible have already been described (Figs. 780 to 782).

The technic of the operation will now be given. It should be the aim of every operating surgeon to avoid making external incisions, when possible. Diseased teeth, followed by abscesses, necrosis or caries of the bone, may be removed intra-orally, together with the bone involved. This may be accomplished with comparative ease. Drainage should be provided.

Partial Resection of the Mandible in Its Horizontal Parts.—Any portion of the body of the mandible may be removed intra-orally. The prevailing custom, however, is to expose the mandible through an external incision. To remove intra-orally that portion of the mandible just anterior to the ramus and as far forward as the cuspid tooth, a retractor is placed in the angle of the mouth and the cheek held back while the tongue is depressed. If the first bicuspid and the third molar are in place they should be extracted. A vertical incision should then be made, just anterior to the ramus, through the mucous membrane, periosteum and as deep into the bone as necessary. Another incision should be made immediately posterior to the cuspid tooth, extending lingually and buccally below the mandibular canal. The question of preserving the periosteum is always to be considered. If normal, it should be saved by dissecting it back. If it is to be removed together with the diseased bone, the incision is started at the lowest point of the posterior incision and carried forward to converge with the point of the anterior incision, and the block of bone removed (Fig. 783). These incisions are made with the use of the surgical engine and circular saw. The nerve and blood-vessels are cut. If there is much hemorrhage, the canals may be plugged with sterile orange-wood sticks. The muco-periosteum should then be brought together with horse-hair sutures. The parts should be irrigated with boric acid or normal salt solution. This should be done frequently.

Partial removal of the bone just described does not change the facial contour, nor will it materially interfere with its function. The adjustment

of prosthesis, therefore, is not necessary. Eventually, after the parts are permanently healed and no longer sensitive to pressure, an artificial denture may be substituted.

There is a popular belief among dentists and many surgeons that the removal of the mandibular nerve and artery must deprive the teeth of sensation and blood supply. The same condition which follows the removal of a nerve in facial neuralgia is maintained here. We have removed the mandibular nerve and blood-vessels and it is unreasonable to assume that the pulps of the teeth will no longer live. Since all the teeth on the affected side are anterior to the field of operation, they are dependent upon anastomosing branches for their nerve and blood supply. It is thus that the vitality

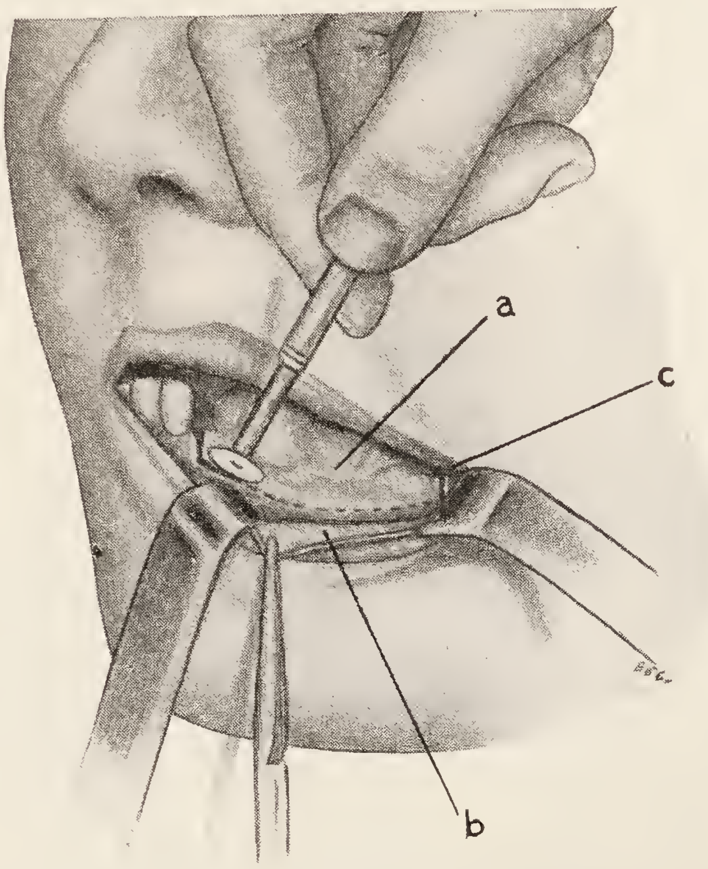


Fig. 783.—The removal of a section of the alveolar process intra-orally. *a*, Tumor; *b*, soft parts dissected from the bone; *c*, posterior incision in the bone from above downward. Dotted line shows the path of the engine saw.

of the teeth is preserved. Undoubtedly the maintenance of vitality comes from the arteries in the immediate neighborhood and from the sympathetic nervous system.

Should occasion require the resection of the anterior part of the mandible, it is important to retain the symphysis and the periosteum. The technic is practically the same as the method described above. This resection causes a marked depression of the lower lip and consequent deformity of the face. An artificial denture, in the form of a bridge or plate, should be adjusted to overcome the deformity.

Partial Resection of the Mandible.—For removal of extensive tumors involving a portion or the whole of the body of the mandible, the bone should be resected. In removing this bone, it is necessary to cut away not

only the growth, but some of the normal tissue, therefore incisions should be made well beyond the tumor.

A section of the mandible involving half of the bone may be removed either intra- or extra-orally. Frequently, only one-half of the mandible is invaded by the disease. If the operation is made intra-orally, a central incisor

FIG. 784.—Periosteal elevator.

tooth should be removed and the bone and mucous membrane divided in the median line with a circular engine saw. The bone is carefully denuded of its periosteum by means of a periosteal elevator. This is passed along the lingual and buccal surfaces of the teeth. A slightly curved periosteotome (Fig. 784) can be employed advantageously to denude the under portion of the

FIG. 785.—Shows line of incisions through the soft parts employed in making a partial or complete resection of the mandible. An incisor tooth is removed to facilitate the cutting of the bone.

bone. After this, an incision is made through the soft parts along the anterior border of the ramus. This portion of the bone is also denuded of its periosteum. The free bone is now dislodged from its articulation by twisting out and inward (Figs. 785 to 790). The articular capsule usually ruptures, but occasionally it may be necessary to divide it with a knife. The hemorrhage

attending this operation is considerable sometimes, but it may always be controlled by catching the vessels as soon as they are divided and by the use of gauze packs for a few minutes. The inferior dental artery and nerve are di-

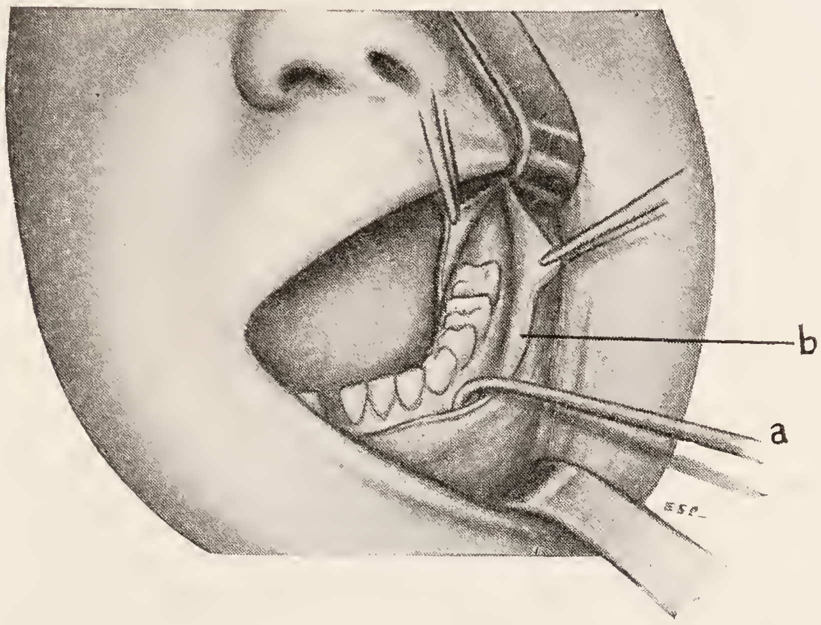


FIG. 786.—Shows muco-periosteum removed from bone (*b*) with curbed periosteal elevator (*a*). The muco-periosteum is removed from the buccal surface in like manner.

FIG. 787.—Shows the bone exposed and engine saw cutting the bone from above downward, just anterior to the ramus; *a*, periosteum reflected back.

vided just as they enter the inferior dental foramen. The artery should be caught before doing this. Immediate prosthesis should be employed (Fig. 791).

The soft parts are then approximated and sutured with horse-hair. Ample drainage is provided by placing a small rubber tube in the wound. This is usually removed in a few days. The pockets left should be irrigated frequently with normal salt solution.

Removal of the Entire Mandible.—To remove the entire mandible intra-orally, it is necessary to proceed in exactly the same way as described above. The periosteum and mucous membrane, if normal, are first separated from the entire bone on both the lingual and the buccal surfaces. The symphysis of the mandible is divided by means of the circular engine saw. After this is done, the right side is loosened and removed from the mouth. Hemor-

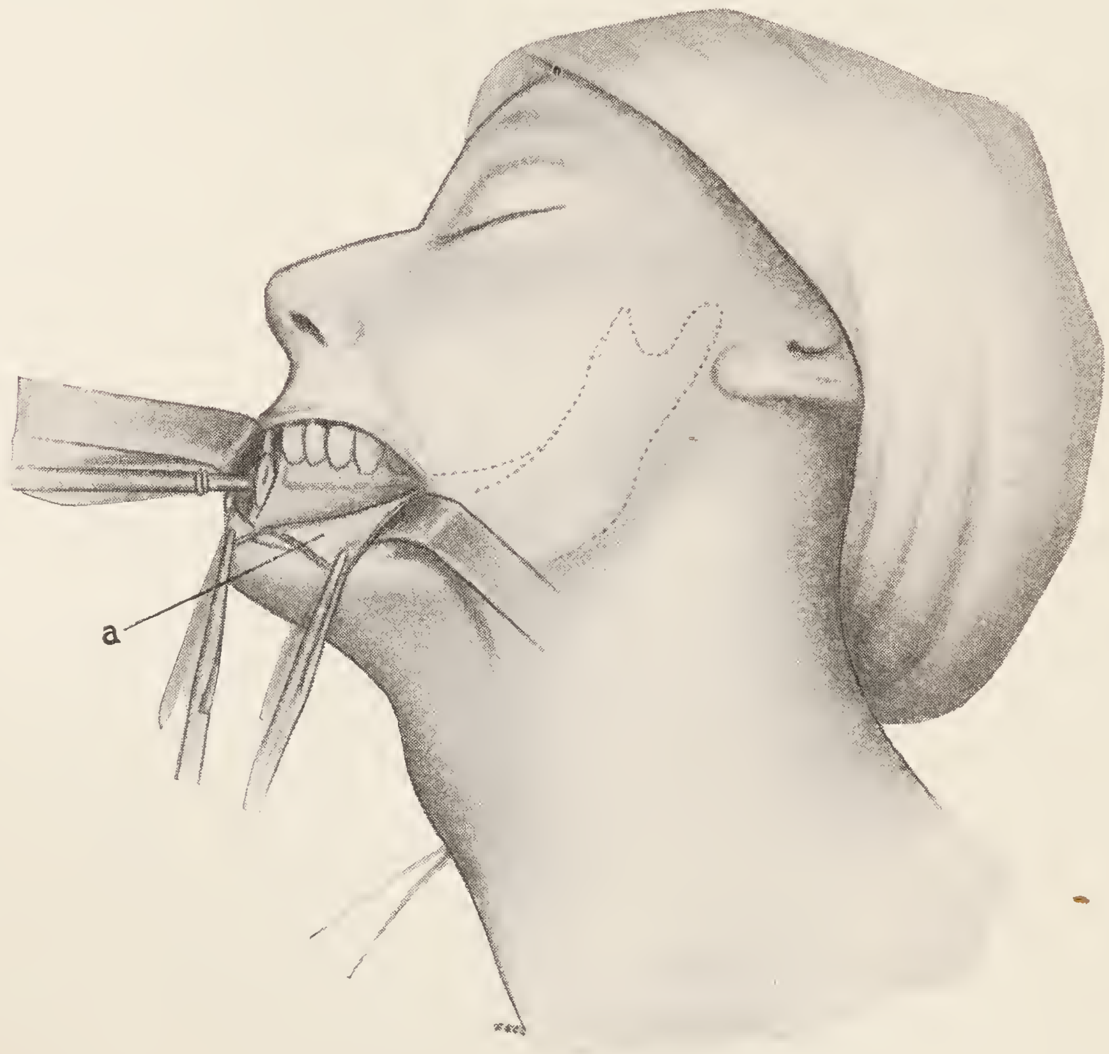


Fig. 788.—Shows engine saw dividing the bone near the symphysis. In this case, the entire bone is being divided. *a*, Muco-periosteum reflected from bone.

rhage is controlled by pressure and ligatures. The left side is treated in the same manner. Immediate prosthesis should be employed. The soft parts are sutured with horse-hair and drainage provided. Generally I do not use rubber tubing for drainage; instead, I find that frequent irrigations give much better results.

The removal of the mandible in part or entire by external incision is accomplished in the following manner:

An incision is made through the skin and soft parts just posterior to the angle of the jaw and carried forward in the shadow line far enough to give access to the greater portion of the bone. The bone is then exposed and divided in the region of the first bicuspid or first molar tooth, as the conditions

require. All the muscular attachments should be divided and the bone, thus freed, may be seized with strong forceps and twisted out of the joint. In the removal of the entire mandible the same general rules apply. Garretson states that "Complete section of the lower jaw is one of the most disfiguring and comfort-destroying operations that is practised on the living being, and is never to be performed without the existence of a well-recognized or proven necessity." The disfigurement of the face, following the loss of the mandible, may be overcome by the skillful adjustment of a prosthesis.

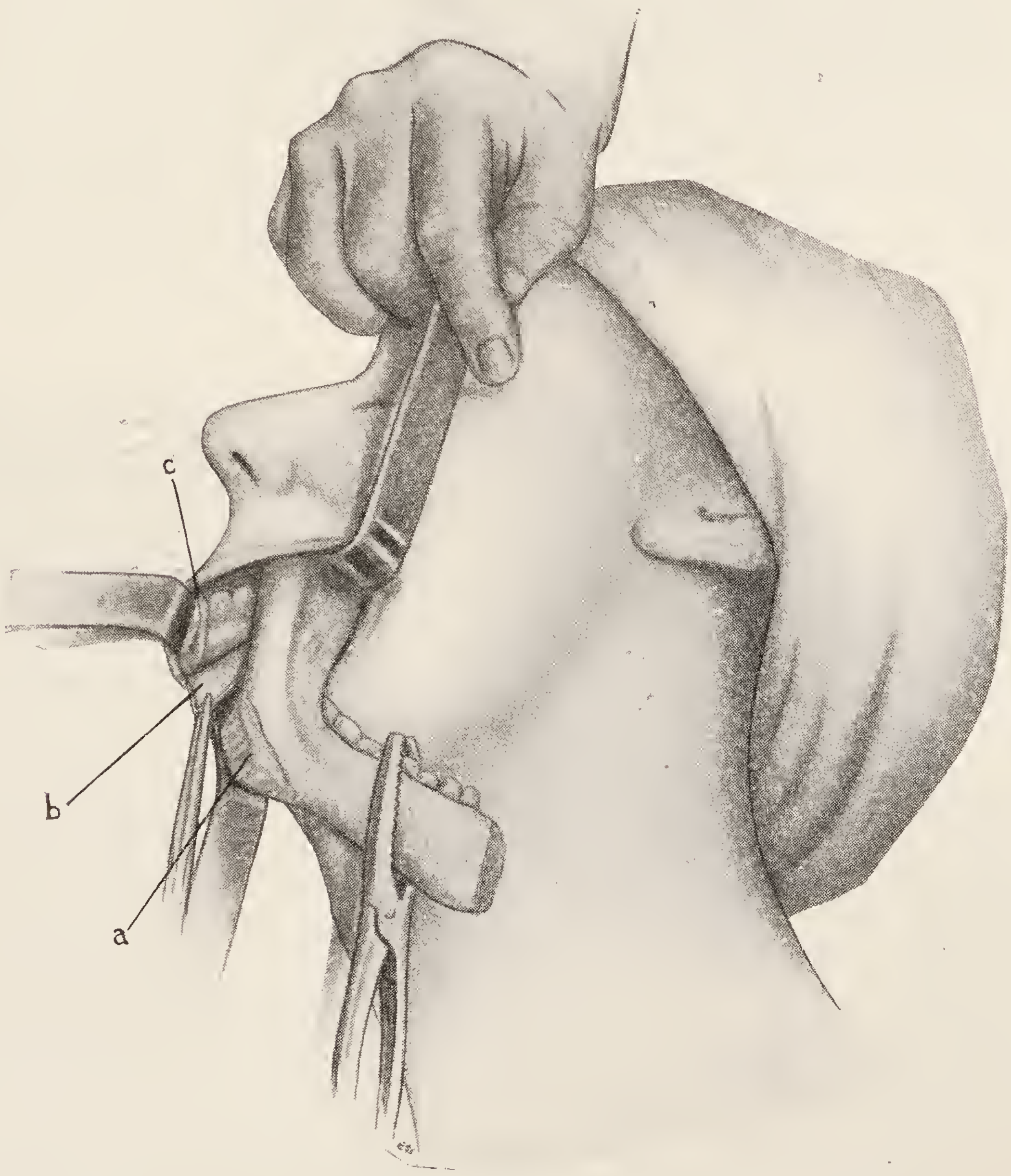


Fig. 789.—Shows half of mandible grasped with strong forceps. It is being disarticulated. *a*, Internal pterygoid muscle cut through at its attachment to the angle of the bone; *b*, reflected muco-periosteum (this should not be removed from the bone as illustrated); *c*, point of division of the mandible.

Resection of the Maxillæ.—The maxillæ need not necessarily be removed entire. Disease may be limited to the dento-alveolar processes or it may involve the entire bone. In certain cases both maxillæ may be affected. The diagnosis once made and confirmed by a Röntgen photograph, it is easy to determine the amount of bone necessary to remove. If we are dealing with necrosis, it will not be difficult to divide the soft parts and remove a sequestrum. If, however, an osseous tumor exists, a skiagraph will outline its borders and indicate the extent of the incisions.

Fig. 790.—Cancerous degeneration of the mandible which was removed intra-orally together with the tumor of the soft parts.

Fig. 791.—*X*-ray showing an artificial substitute of black rubber wired in the mandible. The front wires are covered with gutta percha to prevent irritation. This patient was operated for carcinoma.

Resection of a Portion of the Maxilla.—If it becomes necessary to remove a portion of the maxilla on either side, a careful investigation should be made before operation to determine the best method of removing the bone without

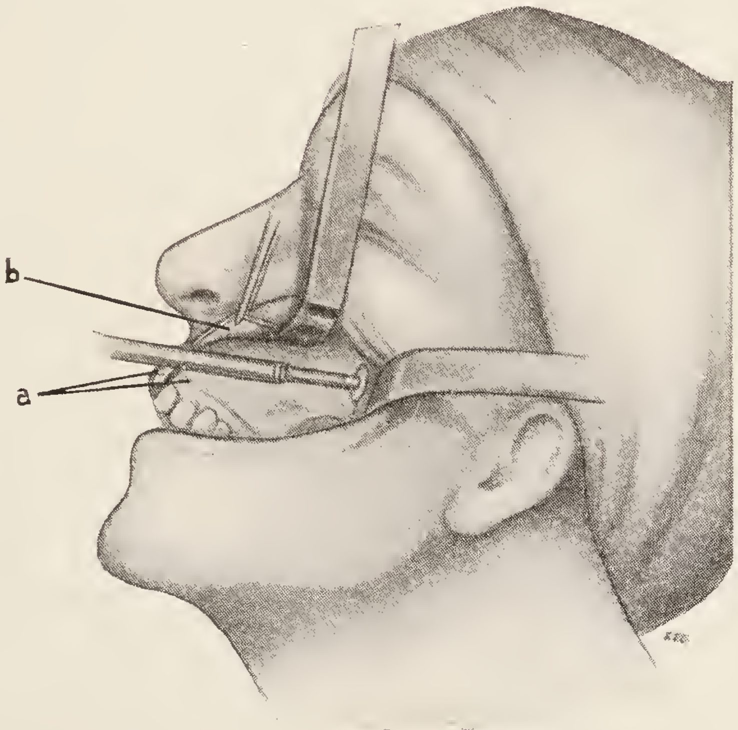


FIG. 792.—Manner of dividing and removing the maxilla intra-orally. The engine saw is dividing the malar process of the bone; *b*, the retractor lifting up the cheek and muco-periosteum; *a*, line of incision of the muco-periosteum.

deforming the patient unnecessarily. Conservatism is urged in making these operations, yet thoroughness is essential. It is possible in the removal of

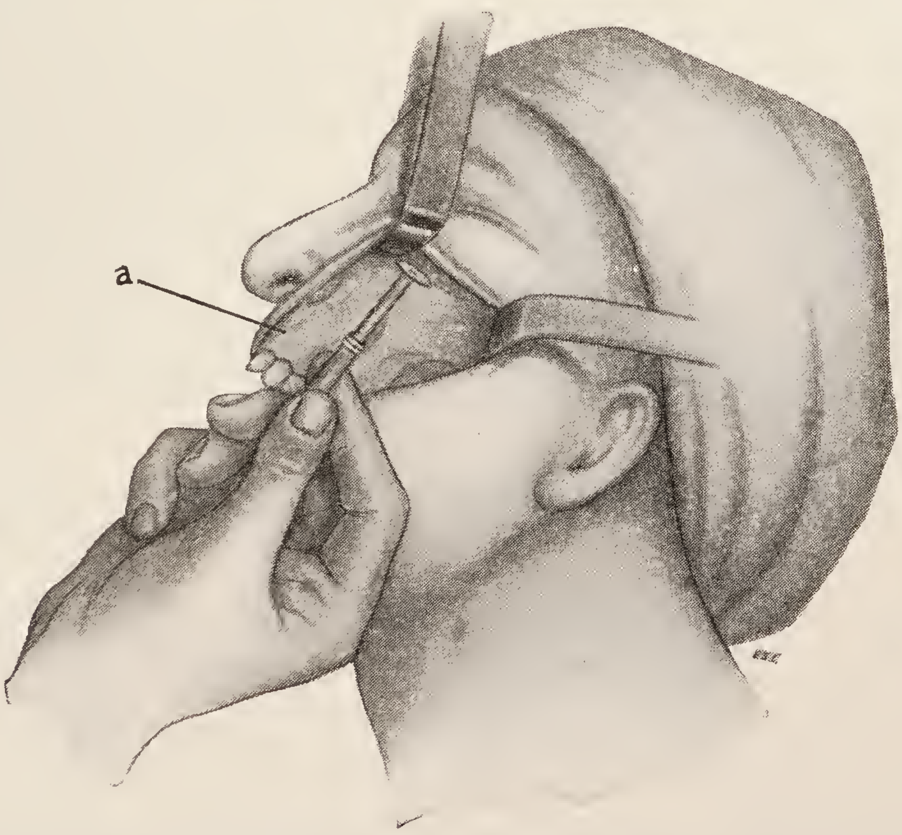


FIG. 793.—Shows engine saw separating the bone, leaving the floor of the orbit intact. The retractors are exposing the nasal and malar process of the bone. *a*, Denuded bone.

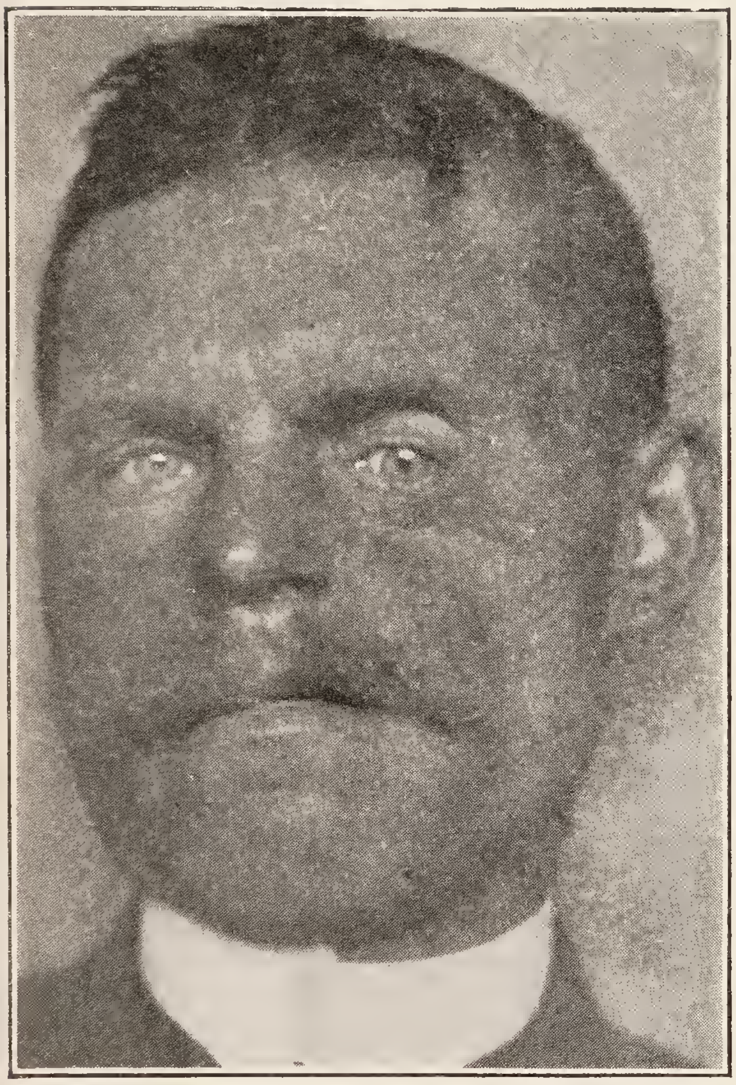
necrotic bone to preserve the teeth. If, however, the alveolar processes supporting the teeth have become necrotic or included in a growth, removal of the teeth will be necessary. If the teeth have been extracted, the incision

should be made along the border of the alveoli, and the soft parts covering the palatal and buccal surfaces should be elevated, thus exposing the bone. If the teeth remain and the external surface of the bone only is involved, an incision should be made a little above the festoon of the gums, the soft parts then elevated and the bone exposed (Figs. 792 and 793). If a tumor is present, it is best removed by means of a chisel or an engine bur, but if the bone is necrotic, a sequestrum should be lifted from its bed by forceps or a bone elevator. After removing a tumor, the soft parts are brought in contact with the freshened surface of the bone and sutured. Often it is quite as satisfactory to place a tampon of gauze between the cheek and the maxilla, which keeps the periosteum in contact with the bone. If a large sequestrum has been removed, it may be just as well to leave the tissues unsutured, since drainage from the parts is thus favored.

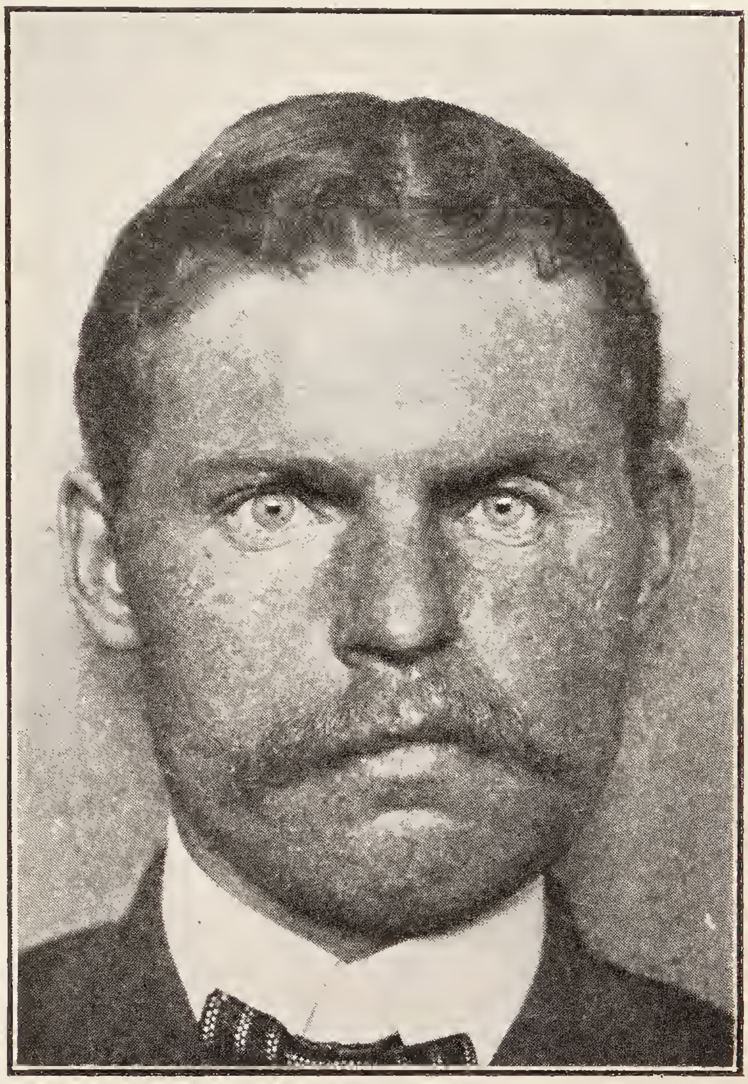
Should a tumor involve the palatal surface of the maxillæ, the greatest precaution must be observed in removing it. The soft parts should be united so as to prevent interference with the function of speech. Often a tumor of the hard palate may be successfully removed piece-meal through the anterior nares. This preserves the integrity of the palate with certainty.

To remove a tumor intra-orally, an incision is made in the median line of the palate and the periosteum and mucous membrane elevated. The bone is thus exposed and the growth may be chiseled away. Having accomplished this, the redundant soft parts are sutured in the median line. It has been my practice to avoid, as far as possible, a division of the palate in removing tumors (Fig. 228). Any tumor of the hard palate may also be removed by the nasal route or through the antrum of Highmore by way of the canine fossa. In operating through the antrum, a horizontal incision is first made over the canine fossa for a distance of about an inch and a quarter. Another incision is carried upward from the center of the first for a distance of a half inch. The muco-periosteal flaps thus outlined are then elevated, exposing the bone. An opening is made through the bone into the antrum and then through the naso-antral wall. The nasal surfaces of the hard palate are now approached. It is vastly important to preserve the integrity of the muco-periosteum which forms the roof of the mouth. Having exposed the nasal surface of the hard palate, we then make use of the chisel to remove the bony tumor piece-meal, exercising great care to avoid perforating the soft parts. After the tumor has been cut away, we have to bear in mind the possibility of post-operative hemorrhage. Should this occur, the posterior and anterior nares should be plugged with a gauze or cotton tampon. The opening between the nose and the antrum may be closed if the operator has been careful in denuding the naso-antral wall of soft parts, leaving a flap which should be sutured with horse-hair or fine silk. The opening through the canine fossa will close itself; the flaps, however, may be sutured. The parts should be irrigated through the nose two or three times daily with boric acid or normal salt solution.

Complete Resection of the Maxillæ.—Resection of both maxillæ is seldom necessary. Moreover, I am of the opinion that the removal of the maxillæ has often been done when only a portion was involved. External incisions are usually made. While I admit that external incisions are sometimes necessary, I am sure the operation may often be done most satisfactorily intra-orally. The work of the surgeon being more easily accomplished through an external incision, he, therefore, prefers to so operate. The disfigured face following external incisions should prompt the surgeon to operate intra-orally when possible. During the past fifteen years I have not had occasion to operate these patients through external incisions.



A



B

FIG. 794.—*A*, Resection of the left maxilla. Depression of the face was corrected by the prosthesis shown in Fig. 843. *B*, Appliance in place. (*Schröder.*)

Nor have I, except in a very few cases, had occasion to remove the floor of the orbit or the infra-orbital ridge. The preservation of the latter is of the greatest importance in retaining facial contour.

Resection of the Entire Maxilla.—The great flexibility of the lips and cheeks enables the operator to retract them as far as need be to expose completely the labial and buccal surfaces of the maxilla. This is accomplished by making an incision from the tuberosity of the bone forward to the median line along the alveolar border. The periosteum, if normal, is denuded from the bone. If no teeth are present, the soft parts covering the hard palate are elevated, using the above incision. If teeth are present, an incision is made along their palatal surfaces and the soft parts elevated, exposing the

bone. An engine bur or chisel divides the bone at the malar process or even as far up as the malar bone. The median suture is then separated and the frontal process of the bone divided. The maxilla is cut away from

A *B*

FIG. 795.—Osteoma of the mandible in a child 10 years old. *A*, Exhibits the growth which involves the left side of mandible from the angle to the cuspid tooth. *B*, After operation.

the orbital plate by a chisel and the bone removed. The soft tissues are replaced in part and sutured. Sufficient space is left through which the wound is packed with gauze. Later prosthesis may be adjusted.

CHAPTER XXXVII

TRIGEMINAL NEURALGIA

Definition.—In the language of Dr. John A. Wyeth "Neuritis of one or more of the branches of this nerve (the fifth), or of the Gasserian Ganglion, is one of the most painful of human maladies and its relief one of the most perplexing problems of surgery." Trigeminal neuralgia, facial neuralgia and trifacial neuralgia are terms which have been used interchangeably in describing pain in and about the face, involving the terminal branches of the fifth pair of nerves. The term "neuralgia" is derived from the Greek roots *neura*, nerve, and *algios*, pain. Hence we have, when translated, nerve-pain, or pain in a nerve. "Under the head of neuralgia," says Prof. Flint, "are embraced a group of local affections characterized by pain occurring without inflammation or any appreciable change in the parts affected. All that can be said of the pathological character of these affections is that they consist in a perversion of sensibility." Again, it is defined as an inflammatory condition of the nerve or neuritis. Spencer and Gask describe it under the heads of epi-neuritis and peri-neuritis, affecting the sheath and perineurium, respectively, a local and ascending neuritis and multiple or peripheral neuritis.

Etiology.—Neuralgia is not a disease *per se.* It is the sequel of general or local disturbances. The general causes are relatively unimportant as an etiological factor. Trigeminal neuralgia may follow in the course of malaria, influenza, syphilis, rheumatism, diphtheria, typhoid fever or any disease of an infectious nature as a result of the toxins. It may be the sequel of poisoning from chemicals, as arsenic, copper, lead, phosphorus, etc.

The local causes are far more important in the etiology of this condition. Neuralgia may be the result of trauma, adhesions from burns or wounds, compression, contusions, strains, cold, blows and falls. Among the causes from compression are tumors, intracranial and otherwise, aneurisms, pressure from fragments following fracture of bone, spiculæ of bone, foreign substances thrust into the tissues, including bullets from gun-shot wounds, metals or other substances which have been crowded through the ends of root canals of the teeth in the act of filling them, stenosis or polypi, or disease of the accessory sinuses of the nose.

Teeth as a Cause.—The most common causes of neuralgia of the second and third divisions of the fifth nerve are dental diseases, injuries following extraction, malformation and malposition of the teeth, impacted teeth, fractures and nerve tumors. The teeth, more frequently than any other

tissue of the body, are subject to disease. They are highly organized and sensitive and abundantly supplied with nerve filaments from the branches of the fifth nerve. Thus it is easy to understand the influence which the teeth, when diseased, exert upon the nerve centers. It is essential to understand the many diseases to which teeth are subject. They are, either directly or indirectly, responsible for a greater number of cases of trifacial neuralgia than all other causes combined. A tooth lesion may involve a nerve and

Fig. 796.

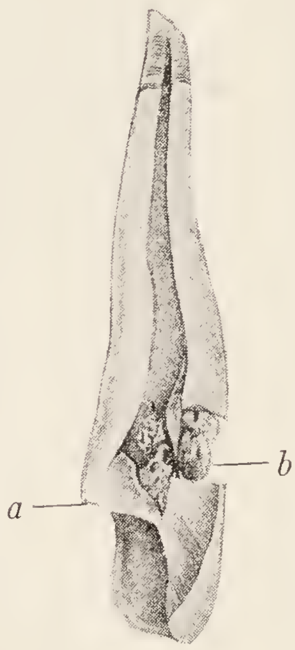


Fig. 797.

Fig. 798.

Fig. 796.—Newly formed dentin bending into the pulp cavity and uniting with the original dentin on the part corresponding to the caries in an incisor. *a*, Caries; *b*, newly formed dentin; *c*, newly formed dentin attached to the root canal. (× 4.) (*Heider.*)

Fig. 797.—Section of a left canine of the maxilla; the masticatory surface (*a*) is worn in such a way that steps are formed. The enamel is entirely gone, exposing the dentin. On the neck of the tooth a penetrating caries is seen (*b*). The pulp is exposed. Newly formed dentin is attached to the wall of the root canal at this point. (× 2.) (*Heider.*)

Fig. 798.—Calcium deposits on blood vessels from a chronic, fatty degenerated pulp of a right, perfectly sound canine in the mandible. *a*, Rounded and sharp protuberances; *b*, vessel partly affected; *c*, blood vessel split by deposit. These deposits frequently produce neuralgia. (*Heider.*)

cause neuritis. Frequently neuralgia is due to the formation of cicatricial tissue about a nerve, induration of a nerve sheath, excementosis or an exostosis of the bony walls surrounding the teeth. Though the diseased teeth may be removed, the abnormality they have established in the surrounding parts may remain to be the nidus of neuralgia of the most severe type. The unsuspecting surgeon, knowing that a tooth was removed which formerly caused pain, may exclude it and the consequence of its disease from consideration in making his diagnosis.

Facial neuralgia may originate from abnormalities of the teeth, as follows:

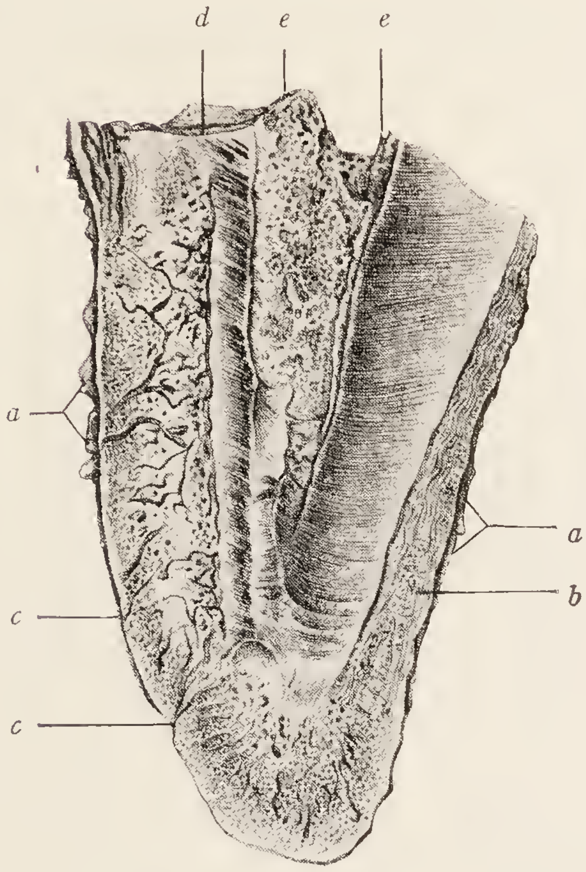


FIG. 799.—Hypertrophy of cementum with many calcified canals in the dentin at the top of a root. *a, a,* Remains of thickened and dull periosteum; *b,* undulating layers of cementum; *c, c,* irregular holes penetrating the superficial cementum; *d,* ramified canals in dentin; *e, e,* resorption of dentin. (× 6.) (*Heider.*)

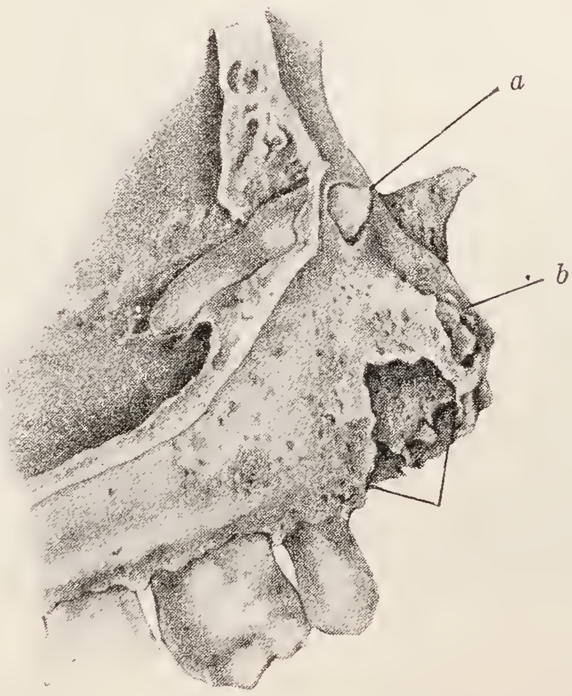


FIG. 800.—Side view of right lateral incisor in a horizontal position implanted in the upper jaw. *a,* Apertura pyriformis. Below the projecting crown (*a*) is seen an analogous sharp-edged round opening (*b*) near the alveolar process. *c,* Empty alveoli. Pressure on the nerve by this tooth will cause neuralgia. (*Heider.*)

I. Teeth which are carious.

a. From a carious tooth with pulp not exposed (Fig. 796), but congested as the result of irritation due to the close proximity of the carious cavity to the pulp chamber.

b. From pulpitis resulting from advanced decay and exposure of a tooth pulp (Fig. 797).

c. From the remaining living nerve branches of the pulp in one root canal, while the branches in another root canal of the same tooth have lost their vitality.

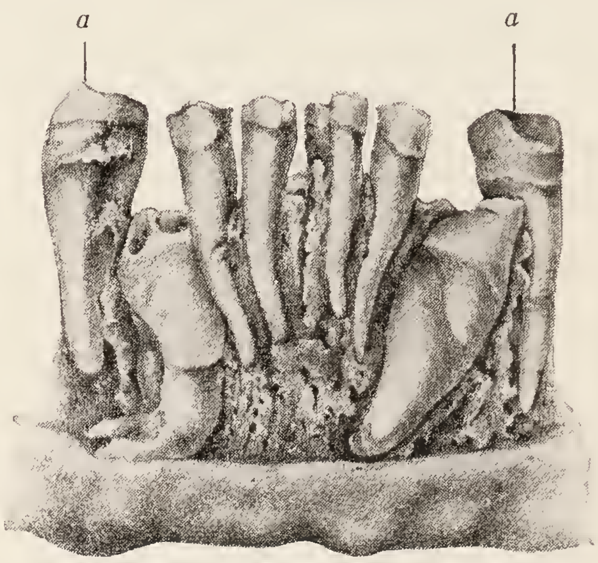


Fig. 801.—Anterior segment of mandible with two canines, which did not appear through the gums of an individual of advanced age. *a–a*, Biscuspids. The pressure of these teeth frequently causes neuralgia. (*Heider.*)

d. From the low vitality of the nerve filaments of the pulp after the blood supply has been depleted (Fig. 798).

e. From pericementitis.

f. From the presence of loose roots, partially exposed to view, which remain as continuous irritants to the surrounding parts (Fig. 799).

Fig. 802.—Unerupted teeth in crowded arches. The roots press upon the mandibular nerve and are a common cause of neuralgia.

II. Teeth which are not carious.

a. From teeth in crowded arches, where pressure is made backward upon the large branches of the nerve (Figs. 800 to 802).

b. From teeth about which the gum tissue has receded, leaving their necks exposed (Figs. 803 to 805). Carious cavities not found by the use of a fine exploring instrument, causing the cementum of the tooth to be ex-

tremely sensitive. The tooth, therefore, is the starting point of extreme pain—a typical neuralgia.

c. From teeth whose pulp cavities have been partially filled by the formation of secondary dentin, or pulp nodules (Figs. 806 to 808). These nodules may be in carious teeth but, not infrequently, are found in teeth with crowns free from decay. These nodules of calcific matter exert pressure upon the nerve filaments of the pulp and oftentimes are the cause of most extreme paroxysms of neuralgic pain.

Fig. 803.—The jaw of the Homo Heidelbergenesis, the oldest genuine relic of man, which was found near Heidelberg. This mandible is preserved in the museum of the University of Heidelberg. It is estimated that the specimen is at least fifty thousand years old. It will be noticed that the bone has receded from the roots of the incisor and bicuspid teeth. This is an etiological factor for neuralgia and oral infection.[1] From a model by the kindness of *C. F Bödecker.*

d. From malposed or impacted teeth which lie in close proximity to the nerve trunk and which exert pressure upon it, especially the lower molars, the roots of which extend deep into the substance of the bone and penetrate the canal, thus pressing upon the mandibular nerve (Figs. 809 and 810). At the end of the roots of such teeth abscesses may form and discharge into the

[1] For further information regarding this specimen, see "Handwörterbuch der Naturwissenschaften," Vol. IV, p. 335. Published by Gustave Fischer, 1913.

canal, causing infection and making pressure which may produce the most intense neuralgia.

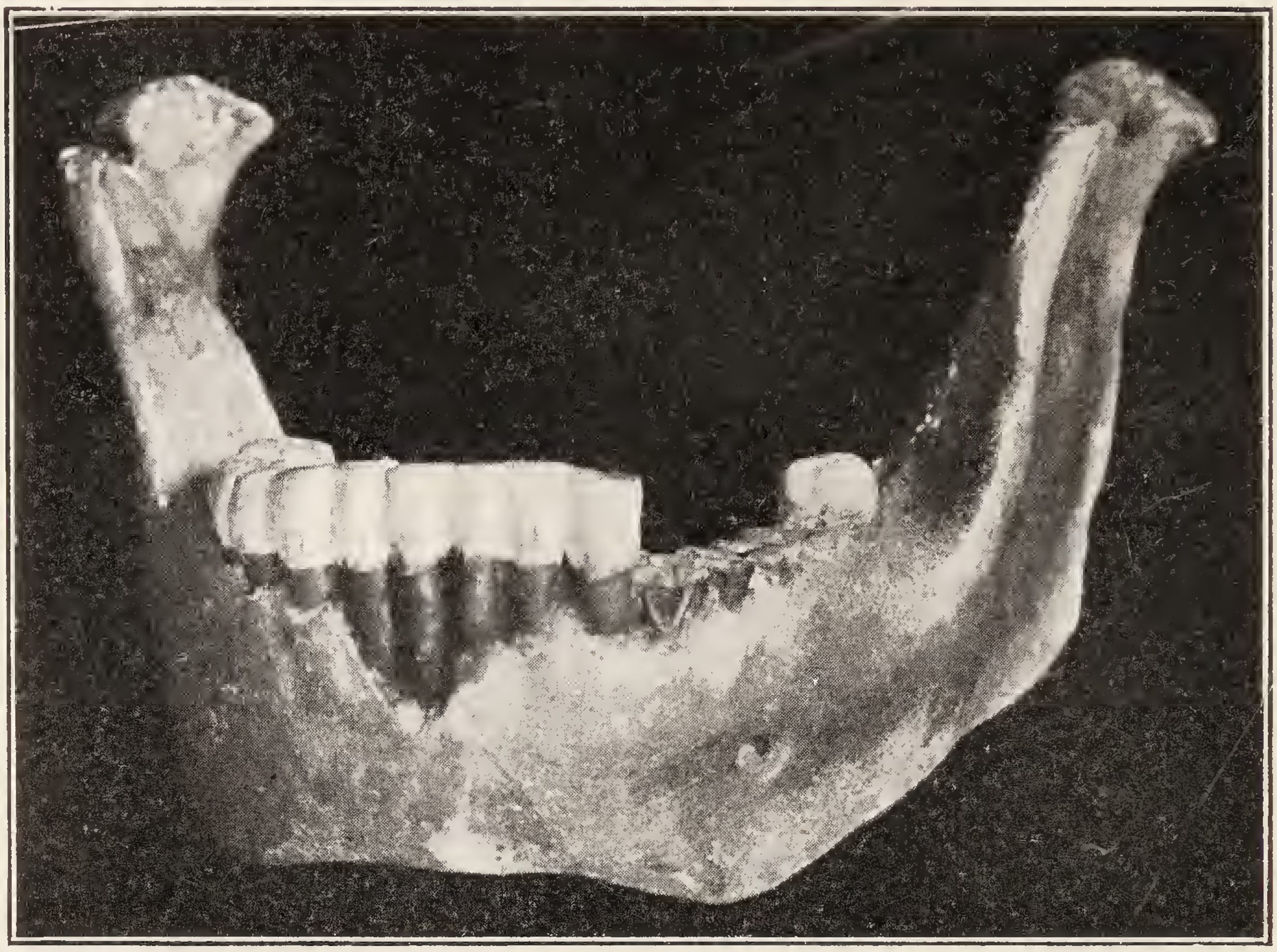


FIG. 804.—See Fig. 803.

FIG. 805.—See Fig. 803.

Impacted teeth, especially lower third molars, instead of assuming a normal upright position, may lie parallel to the body of the bone with the roots exerting pressure on the trunk of the nerve. The lower third molar

FIG. 806.—Transverse section from the neck of a molar much worn on its masticatory surface. Amber-colored dentin nearly fills the cavity of the pulp. This is intimately united with the dentin of the tooth proper. Deposits of secondary dentin in the pulp cavity exert pressure on the nerve filaments of the pulp and frequently cause neuralgia. The diagnosis of this condition was formerly very difficult. With the advent of the Röntgen photograph, the diagnosis is easier. (× 7.) (*Heider.*)

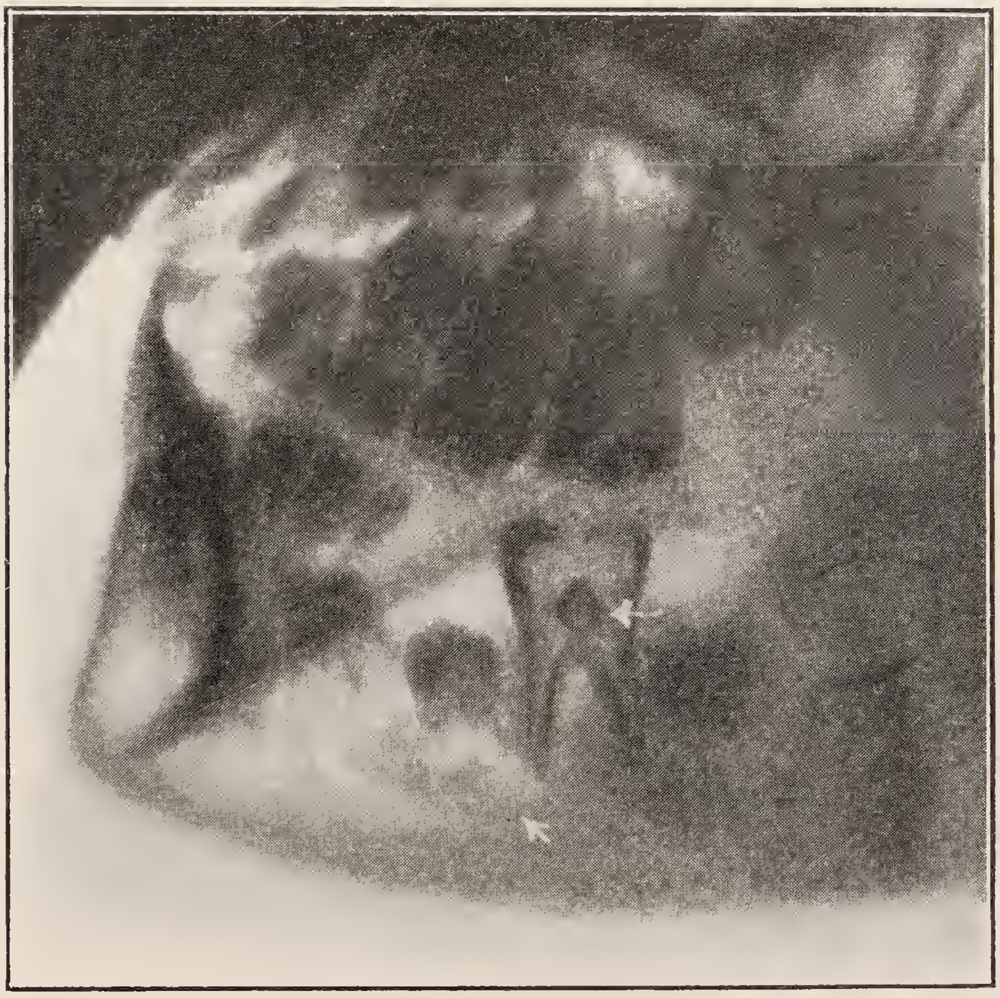


FIG. 807.—A pulp stone in the lower first molar, in a child nine or ten years of age. A condition which may cause neuralgia. (*Cryer.*)

may extend upward and inward through the ramus of the bone, its crown finding exit at the point occupied by the inferior dental foramen. (See Impacted Teeth.) Pressing upon the inferior dental nerve, it becomes the

FIG. 808.—Section of pulp in the root of a tooth from an old person. The concrements of calcium are round, oval or elongated. The dimensions change from a minute granule (*b*) to a formless clump (*c*). The latter often show clefts and manifold incisures. Bundles of nerves or blood-vessels are still recognizable (*a*, *a*). The presence of these deposits of calcium salts exert pressure upon the nerve filaments of the tooth pulp. They are oftentimes the initial lesion of neuralgia. (× 350.) (*Heider.*)

FIG. 809.—Impacted third molar causing neuralgia by pressure on the inferior maxillary nerve. (*Cryer.*)

seat of neuralgia. Such a tooth may move upward and into the sigmoid notch (Fig. 811), or it may pass outward and through the cheek. The

FIG. 810.—A molar tooth which partially occupied the mandibular canal. This is a common cause of neuralgia.

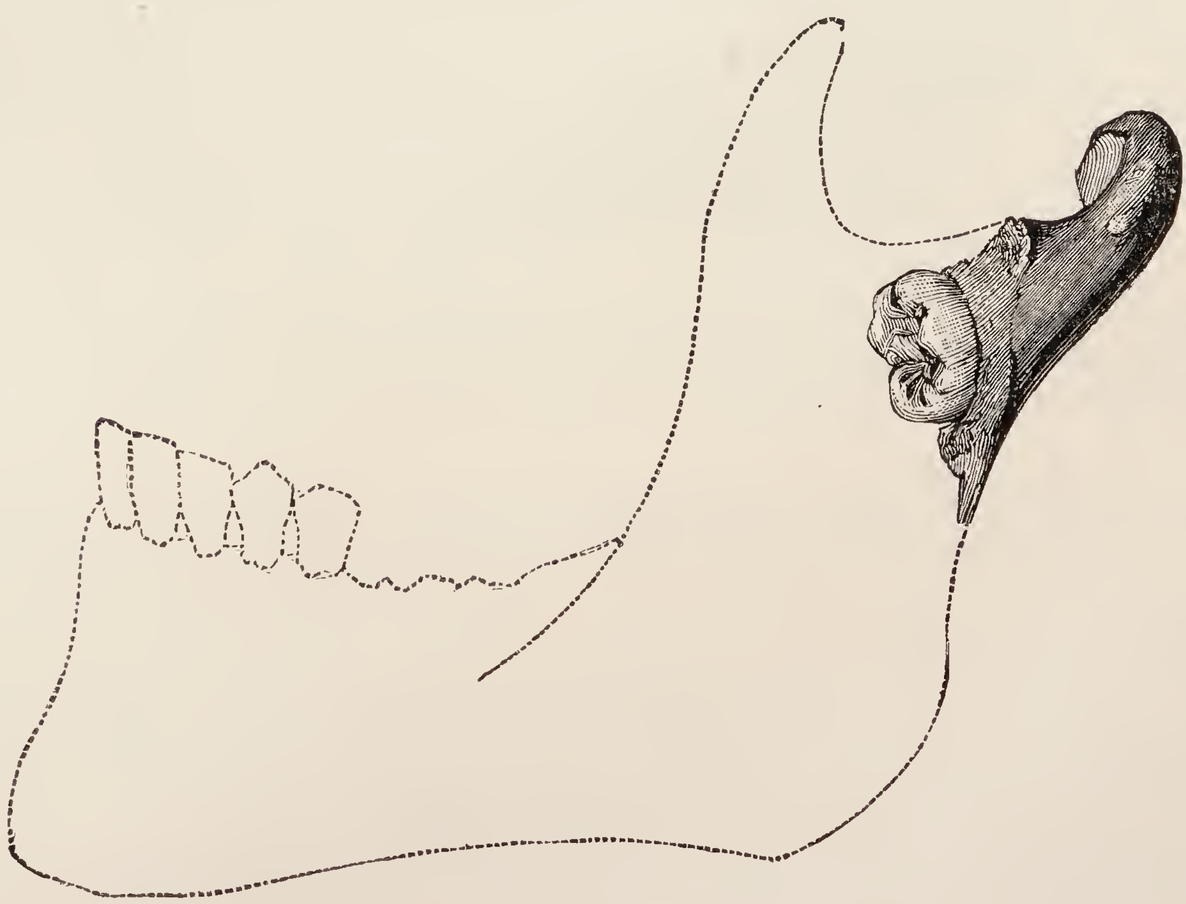


FIG. 811.—Dentigerous cyst, with inverted third molar. (*Marshall.*)

upper third molar may pass backward into the spheno-maxillary fissure (Fig. 812), exert pressure upon the posterior dental nerve and thus become the center of neuralgia.

The cuspid teeth, or any upper incisor tooth, may be diverted from their course, pass upward into the infra-orbital canal in contact with the nerve as it is about to emerge from the infra-orbital foramen, and there become the seat of neuralgia (Fig. 813).

Fig. 812.—This patient had been a sufferer from neuralgia for fifteen years. This skiagraph reveals the presence of a third molar in the spheno-maxillary fissure. Its pressure upon the posterior dental nerve causes the neuralgia. After removing the tooth intra-orally the neuralgia was cured.

Any tooth may take an abnormal position, migrate to an unexposed place, come in contact with important nerve branches and excite trigeminal neuralgia.

e. From teeth which, by reason of an inflammation of their membranes, develop hypertrophy of the cementum—excementosis or hypercementosis. The development of this abnormal growth of the cementum exerts great pressure upon the surrounding part, including the nerves.

Construction.—No training so thoroughly prepares a man for the work

III. Injuries and local irritations in and about the teeth.

a. From the passage of foreign substances, in the form of root fillings, through the end of the roots (Figs. 814 and 815).

b. From badly fitting tooth crowns (Fig. 816) which extend beneath the gums and into the periosteum, thus becoming centers of irritation.

FIG. 813.—Illustrates a skull from the Hunterian collection, Royal College of Surgeons, London, which shows a cuspid tooth upon the right side emerging just beneath and to the inner side of the orbit. Its root partially fills the infra-orbital canal. The left cuspid is higher up and emerges into the orbit. Its root is directed downward. These teeth (especially the right one) are so situated that pressure must necessarily have been exerted upon the infra-orbital nerve. The anterior surface of the root of the first right bicuspid tooth is partially exposed due to caries of the bone. This is another source of irritation which might readily cause neuralgia.

c. From the application of clasps to the necks of the teeth in the adjustment of artificial dentures

d. From the deposits of salivary calculus upon the roots of the teeth, causing irritation of the surrounding membranes.

e. From malocclusion of the teeth, forcing them far out of their alignment and the roots making undue pressure upon their surrounding walls.

f. From teeth which have none occluding with them in the opposite jaw.

For want of contact, such teeth rise in their sockets and oftentimes an irritation develops about the roots.

FIG. 814.

FIG. 815.

FIG. 814.—Illustrates the presence of a foreign substance carried through the apex of a tooth root in the act of filling it. There is an extensive destruction of the bone. The irritation has unquestionably extended to the adjacent nerve. A suppurative process may have existed prior to the insertion of the canal filling. A metal cap covering the tooth fits badly and also may have been a cause for the irritation.

FIG. 815.—Illustrates a bicuspid and a molar tooth, the pulp canals of which have been filled. A portion of the canal filling has passed beyond the apex of the root and about which areas of disease exist.

g. From pressure upon the membrane caused by badly contoured fillings (Fig. 817) or poor approximation. Metal incompatibilities, tooth-picks, etc., may develop an irritation. When a gold filling comes in contact with an

FIG. 816.

FIG. 817.

FIG. 816.—A molar tooth upon which a badly fitting crown has been adjusted. The edges of the crown extend into the soft parts and impinge upon the periosteum. This will produce sufficient irritation to cause neuralgia.

FIG. 817.—Canal fillings extending beyond the apex of the tooth root and large metal fillings overlapping the cervical borders. These sharp edges are a source of irritation to the soft parts and if permitted to remain are a frequent cause of neuralgia.

amalgam filling, most severe pain may ensue. They are like a battery and the current passing between them produces a shock to the nerves

with great pain. The fillings need not necessarily be in contact. Sometimes a tooth with two small cavities in it *filled with different metals may be the center from which severe neuralgia may originate.* The pain will be permanently cured in such cases by removing one of the fillings.

h. From injuries to the alveolar processes in the extraction of teeth, in the form of fractures of the external and internal alveolar plates, leaving spiculæ of bone to remain as irritants.

i. From artificial dentures, adapted to the edentulous. In the aged, the mental foramen should be seen nearly and, in some instances, quite upon the summit of the alveolar ridge. The mandibular nerve, making its exit from the mental foramen, lies only submucous. It may be easily felt as it emerges from the canal. An artificial denture, adjusted without having this anatomical fact in view, is very certain to make undue pressure upon the nerve.

The principle in adjusting a denture should be the same as making a saddle to fit a horse's back. It is always fitted so that the pressure does not come upon the spine, but is made lateral to it upon the muscular portion of the back. Failure to construct a complete lower denture saddle-like, so as to relieve pressure upon the nerve at its exit from the mental foramen, is the explanation of the complaint among aged people and others who wear full lower dentures. While the plate is in, paroxysms of pain occur identical with the toothache to which they were subject prior to the extraction of all the teeth; on removal of the plate the pain is relieved. The persistent irritation of the unwisely constructed plate leads to an irritation of the nerve, resulting in hypertrophy. Neuralgia is almost certain to ensue.

The same condition often exists in relation to full upper dentures, since pressure exerted upon the anterior branches of the palatine nerve will produce a like result—irritation, hypertrophy and, in some instances, neuroma, followed by neuralgia. Here, too, the dentist must so construct the plate that pressure cannot be made upon the nerve as it makes its exit from the incisive foramen.

Hypertrophy and Atrophy of the Second and Third Divisions of the Fifth Nerve.—In the study of the etiology of trigeminal neuralgia, authors have truly stated that it is often impossible to discover its origin. Especially is this the case in tic douloureux. Prior to the advent of Röntgen photography, many cases of neuralgia, the origin of which I have pointed out above, were classified in the list of unknown causes. The presence of atrophy, hypertrophy or neuromata cannot be determined by skiagraphy. We know that these conditions are causes of neuralgia. We know that trigeminal neuralgia occurs more frequently in the second and third divisions of the fifth nerve than in the first, and this is due to the following reasons:

First Division:

a. It is not directly disturbed by lesions of the teeth.

b. It is less exposed than the other branches and less subject to trauma.

c. The bony canal it traverses is not so long and hypertrophy of the nerve is not restricted by pressure to so great an extent.

Second Division:

This is exposed to direct violence, blows on the face, etc. Lesions of the teeth, antrum[1] and nose are many.

Third Division:

Like the second division, it is exposed to blows and lesions of the teeth.

In looking into the etiology of this condition, as in all others, the most satisfactory course to pursue is to conduct the examination by exclusion, never forgetting that teeth, which seem to be free from disease, may be factors in causing neuralgia.

Age and Sex.—In my experience neuralgia is a condition which occurs most frequently in middle life and beyond, although it may develop in younger subjects. The oldest patient on whom I have operated was seventy-five years of age and the youngest twenty-three. Very little difference seems to exist as to the prevalence between the two sexes. Personally, I have seen more cases occurring in men, while Sir Horsley had a slight preponderance of women.

In a recent article, Dr. Hugh T. Patrick[2] tabulates 200 cases, in which 96 were men and 104 women. The age of onset of the trigeminal neuralgia is given by him in the following table:

Decade	Number	Per cent.
First	1	0.5
Second	3	1.5
Third	11	5.5
Fourth	37	18.5
Fifth	56	28.0
Sixth	59	29.5
Seventh	25	12.5
Eighth	8	4.0

Regarding the predisposition, Patrick says: "The diversity of opinions concerning predisposition almost forces one to conclude that nothing definite is known. . . . The problem of neuropathic predisposition is a poor one for statistical solution. The answer must largely be one of opinion. I have the impression that my patients were rather more nervous than the average, but certainly, as a class, they have not been essentially or even notably neurotic. That there is no direct and similar heredity in facial neuralgia seems quite clear, though in seven of my cases there was a history of this disease in descendants or other relatives, in no case was a parent affected. . . . Migraine has been by far the most frequent neurologic concomitant. Of 200 patients, 40 may be fairly said to have had mi-

[1] See Disease of the Antrum.

[2] "The Symptomatology of Trifacial Neuralgia." J. A. M. A., Vol. LXII, p. 1519, 1914.

graine—certainly a much higher ratio than that observed in the ordinary run of patients."

Anatomy.—The fifth, or largest, cranial nerve is the principal sensory and motor nerve supplying the head and face. It arises from two roots and contains a ganglion, thus resembling a spinal nerve. The larger, or sensory, root arises from the Gasserian ganglion located outside of the brain. The fibers from this ganglion are T-shaped and send one branch to the periphery and another to the brain. Those which enter the brain soon divide into two bundles, one ascending and the other descending. At the point of entrance into the brain, there is a considerable thickening. This is known as the sensory nucleus. Below this is found the nucleus of the spinal column. The descending fibers form the spinal tract of the trigeminus. They end at the second cervical segment of the cord. The ascending branches end in the sensory nucleus.

The motor portion of the nerve arises from two roots: one from a nucleus near the sensory nucleus; the other from the mesencephalic nucleus near the locus cœruleus. These fibers pass through the mesencephalon to the pons. The distribution of these roots is not understood thoroughly.

The Gasserian ganglion is very important from our standpoint, especially in the treatment of trigeminal neuralgia. This ganglion (also known as the semilunar ganglion) is located in Meckel's cave. This is situated in the dura mater and in a depression in the surface of the petrous portion of the temporal bone. The cavernous sinus and the internal carotid artery lie close to the inner end of the ganglion, while the foramen ovale is found at the outer side. From the convex side three large nerves are given off. These are the ophthalmic, maxillary and mandibular. On the concave side the sensory root arises. The temporal lobe of the brain lies above the ganglion. The sensory fibers pass over the upper border of the petrous portion of the temporal bone and below the superior petrosal sinus into the posterior fossa of the cranium. From here it takes a backward, median and downward direction, thus reaching the pons.

Regarding the innervation of the teeth, Head states as follows:

"The exact innervation of each tooth from the segmental areas seems to vary somewhat, but the following table gives the approximate supply as it has been worked out at present:

Upper Jaw		Lower Jaw	
Incisors	Fronto-nasal	Incisors	Mental
Canine	Naso-labial	Canine	Mental
1st Bicuspid	Naso-labial	1st Bicuspid	Mental
2nd Bicuspid	Temporal or maxillary	2nd Bicuspid	Doubtful
1st Molar	Maxillary	1st Molar	Hyoid
2nd Molar	Mandibular	2nd Molar	Hyoid
3rd Molar	Mandibular	3rd Molar	Superior laryngeal or hyoid

Classification of Neuralgia.—The classification of trigeminal neuralgia has been based upon the views of different authors in accord with their interpretation of symptoms. We have, therefore, nearly as many classifications as we have authors. In the one prepared by Dr. Henry Head of the London Hospital, we find a classification which seems to meet all the requirements. It is terse and logical. He classifies this condition as follows:[1]

1. Neuralgia quinti major (tic douloureux), epileptiform neuralgia.
2. Neuralgia secondary to disease of the nerves of the head; tumors involving the fifth nerve, post-herpetic neuralgia and the like.
3. Neuralgia minor.
   This group contains:
   (a) True referred visceral pains due to disease of the intimate structure of some organ of the head.
   (b) Pains due to disease of the membranes or tissues surrounding some organ or to actual affection of the finer nerve twigs by morbid process.
   (c) Neuralgias of the head and face arising as direct consequences of disease in organs other than those of the head.
4. Neuralgias arising from general bodily states, such as neuresthenia, psychasthenia and hysteria.

In this article we are particularly interested in the first two headings.

Symptoms.—In tic douloureux a variety of symptoms is manifest. A sense of unrest and discomfort in the part of the face involved precedes the sharp, lancinating pain. The pain may occur suddenly, without warning or the slightest indication of its approach. This may appear anywhere along the course of the terminal branches of the fifth nerve. There may be one or more centers from which the pain originates. The severity of the pain frequently causes contractions of the muscles, with contortions of the face. Thus the spasms may appear suddenly. The pain is most excruciating and, while the suffering is extreme, it will disappear as suddenly. In the interim between spasms there may be absolute rest and freedom from pain, or there may be a dull aching which is not hard to bear. The pain does not appear in regular intervals and, as the period lengthens, the patient is led to believe that he will not have a recurrence, when suddenly, without warning, there is a paroxysm of burning, boring, darting pain which increases in severity and duration. The patient will sometimes place his head in his hands while his whole body is convulsed with rigor and pain. I have seen patients lie upon the floor, with their heads in their hands and their knees approaching their faces, crying out with pain. Under the violence of pain I have seen men whose hair was worn off to the scalp and beards worn to the skin, the result of rubbing the parts when spasms were on. Paroxysm of pain may be induced by the slightest touch of the beard or mustache. It may be influenced by a current of air, by the act of speaking or touching the lips or parts

[1] Allbutt & Rolleston System of Medicine, Vol. VII, 541.

involved with the fingers. A jar or a loud noise, movements of the muscles of the face, movement of the tongue, laughing, coughing or blowing the nose may induce a spasm.

Tic is a most eccentric malady. It has been known to occur with all its violence, with spasms lasting an hour or less, never to recur. One of the characteristics of tic douloureux is that it may remit during the progress of any other disease. On the other hand, it may extend over a period of a long life at frequent intervals. From a patient upon whom I operated at a public clinic, I learned that he had been a victim of tic douloureux for many years. This man first complained of pain in the third division of the fifth nerve, which was located at the mental foramen. The slightest touch on his face in that region would bring on a paroxysm of pain. The pain was described by him as a "shooting pain" which began in the region of the mental foramen. It soon became so violent that he was thrown into a rigor. This man wore a heavy beard, and the slightest touch to the end of the long hair would throw him into a spasm. For relief the teeth had been removed one at a time until he became edentulous, but he still retained his neuralgia.

Under the violence of the agony the face flushes, the eyes become distended, the muscles are fixed and the tension of the face is extreme. With the passing of the spasm the face relaxes, the equilibrium of the circulation becomes re-established and there is a relaxation with more or less exhaustion.

In the supra-orbital form of neuralgia we have, as an early symptom, tenderness of the scalp and tissues surrounding the nerve as it passes upward in its course. These are marked by the passage of the fingers over the forehead. Pressure over the supra-orbital notch or foramen will meet with a quick response of pain. Brushing the hair over the tender areas of the scalp will also be attended by pain. There may be pain within the eye-ball. Light sometimes affects the eye. Occasionally this is followed by conjunctivitis. Pressure of the hat is intolerable oftentimes. Pain is induced in the act of washing the forehead.

When the second division of the fifth nerve is involved, the pain is induced by placing the finger over the infra-orbital foramen. The terminal branches of the second division extend to the nose, the upper lip and the cheek, pressure upon any one of which may induce a spasm. Accompanying the attacks of pain there may be an excessive discharge of nasal and buccal mucus, saliva and tears. A slight touch on the part supplied by the nerve may bring on pain, not only locally, but in parts quite remote. All the salivary glands are brought into greater activity, by reason of the pain. The pain may seem to be in the teeth and the demand is sometimes made for the extraction of teeth which are absolutely healthy.

The severity of the pain in trigeminal neuralgia may destroy the pigment of the hair follicles of the eyebrow and lashes, leaving them absolutely white.

The following is a typical case of infra-orbital neuralgia: The patient, a woman of thirty-six, had been suffering for two years from pain over the terminal branches on the right side. The pain was intermittent in character, the paroxysms occurring every twenty to twenty-five minutes. They were extreme. When the pain terminated she was quite comfortable, but the dread and fear of its recurrence gave her face a distressed look. There were periods of freedom from pain extending over an hour or two. The slightest touch on the upper lip, nose or cheek on the right side caused the pain to recur. It was with extreme difficulty that she took her food. Her normal weight was 145 pounds, but she was reduced to 117 pounds. In the diagnosis of her case it was not possible to discover the etiological factor. Local application, injections of osmic acid, later deep alcohol injections and medicinal treatment failed to give more than temporary relief. The infra-orbital branch was removed intra-orally, with cessation of all symptoms. On exposure of the nerve as it emerged from the infra-orbital foramen, it was found to be greatly enlarged. That part outside the foramen was at least three times as large as that portion in the canal. No doubt, in this case, the neuralgia was the result of trauma which occurred some years previously, but was not remembered by the individual.

In the third division or mandibular branch the pain is most severe when the lower lip is touched, though it may be developed anywhere along the course of the nerve, at the mental foramen or upon the lingual surface of the bone. Any movement of the muscles of the face will produce the spasm.

A man, aged 75, had been a sufferer from mandibular neuralgia for over fifty years. He was a tall, powerfully built farmer, who, from time to time, had had his teeth extracted until none were left. The loss of a tooth and blood gave him temporary relief, the pain recurring with equal violence. He had also received the usual treatment for neuralgia. In a public clinic before the Illinois State Dental Society, I completely removed the mandibular nerve on the left side. So great was the relief that he declared it seemed like a new life to him. In this case, also, the nerve was found to be greatly enlarged at the mental foramen. During the five years subsequent to operation he was free from pain, after which time he disappeared from observation.

An interesting case of trigeminal neuralgia came into my charge in 1877.[1] A gentleman, aged 38, consulted me with reference to pain located by him in the left second superior molar. A careful examination revealed no caries, calculus or periosteitis, but a slight congestion of the gums was present. There was also slight inflammation of the face at the terminal branches of the infraorbital nerve. He requested me to extract the tooth described, but I refused. Tincture of aconite was applied to the gums and the following prescription given him:

[1] Reported in Missouri Dental Journal, Vol. 12, p. 145, 1880.

℞.
Prussiate of Potassium .... ʒi
Eau de Cologne,
Tincture of Aconite (Fleming's) .... āā ℥i
M. Sig. Dilute with water and apply with sponge every two to three hours.

His condition was much improved the next day. The paroxysms of pain occurred at greater intervals and were less severe. Quinine sulphate, grs. xxiv, in four doses, and a continuation of the local treatment were prescribed. Two days later he seemed to be well. During the following week the paroxysms returned and he was placed on the same treatment again. He declared himself free from pain in three days. About a week later he informed me that a physician had removed from him a tapeworm 48 feet in length. The cause of the disturbance of the nervous system, with the neuralgic pain, was at once understood. The day following the removal of the tapeworm, the local applications were frequently resorted to for control of the occasional paroxysms of pain. I saw this patient in 1880, when I learned that no trace of neuralgia had since recurred.

Diagnosis.—The literature on the subject of trigeminal neuralgia is filled with admissions from most eminent writers that the origin of the condition oftentimes is not understood. As in the management of other abnormalities, the most important consideration is an accurate diagnosis. I do not know of any condition which calls for greater care and patience on the part of the diagnostician and a more searching examination of the history and present condition of the case than is required in making a diagnosis of trigeminal neuralgia. Proceeding with the history and by exclusion, ruling out one possible cause after another, the diagnostician is able, in most cases, to reach a satisfactory conclusion as to the origin of the pain.

Prior to the advent of the Röntgen photograph, the presence of local irritants, such as abnormalities of the teeth, malposed teeth, foreign substances in the tissues, bony growths, etc., was not easily discovered. Many cases have come under my observation, the treatment of which consisted chiefly in internal medication for the cure of the neuralgia, when local irritation was found to have been the sole cause of the disturbance.

With a knowledge of the history of the patient, his family history, his occupation and his environment, whether he has been subject to poisoning from any of the agents named or to any of the diseases which might lower his vitality and thus deplete his nervous energy, whether he has been subject to any injury or to dental irritation, we should be able to learn something to assist us in making our diagnosis.

Failing to find anything subjectively or objectively to convince us as to the origin of the condition, we should then secure a Röntgen photograph made by an expert. This photograph should be so clear that anything which is not anatomically normal may be recognized easily. The history of trigem-

inal neuralgia has in it innumerable instances of cases treated by internal medication alone, when, in the light of modern diagnostic facilities, it has been traced to local irritants.

With these facts standing so conspicuously before us, we are led to the belief that nearly all cases of neuralgia, trigeminal and otherwise, are due to a local irritant somewhere along the course of the nerve, possibly in contact with the sensorium commune itself.

In the rapid advancement of the science of neurology, may we not expect that same degree of accuracy to develop in locating a nerve lesion that we now have in locating a break in the Atlantic cable?

In making a diagnosis of this condition, every suspected factor should be considered carefully and the examination should be most searching. All the teeth should be examined thoroughly on all their surfaces and beneath the gum when conditions seem to call for it. Transillumination should be employed; the nose, throat and ear should be examined. Digital manipulation of the parts is employed with a view to locating hypersensitiveness of the nerve, thus outlining the area involved, which gives a hint as to the division of the nerve diseased or affected.

In my opinion the exposed dental pulp represents the closest approach to trigeminal neuralgia. However, one should eliminate disease of the antrum, diseases of the parotid, and impacted and malformed teeth.

Treatment.—I have previously stated that the principal cause of trifacial neuralgia is local irritation. I believe the cause is chiefly local whether discovered or not. In making this statement, I am not unaware of the fact that facial neuralgia may have its origin in parts of the body quite remote from the seat of pain, as I have pointed out in the citation of some cases in private and clinical practice.

The *first* step is medication with a view to arresting the pain temporarily —the use of anodynes, such as phenacetin, salol, aconite, nitroglycerin, or hypodermic injections of codein or morphin. For quick relief, chloroform may be used and, in cases not so severe, potassium bromid. As in the administration of anodynes in the treatment of other maladies, danger of establishing the drug habit must be kept in mind constantly. Morphin, cocain, codein and the bromids should not be continued over a lengthy period.

The *second* step in the treatment is to discover and remove the local causes, if any, such as foreign bodies, pressure of bone, irritation of teeth whether from disease, malposition or impaction, improper adjustment of artificial dentures, scar tissue, adhesions, callous, exostosis of bone, crowded dental arches, etc.

The *third* step is the treatment of the general causes, such as malaria, anemia, syphilis, gonorrhea, etc.

The *fourth* step is local treatment. One of the most efficient local remedies for the treatment of peripheral neuralgia is menthol, the crystals of which may be dissolved in alcohol and then diluted about one-half with water.

Several thicknesses of flannel should be saturated with this solution and laid over the region of the pain. This, covered with oil silk to prevent evaporation, will usually bring temporary relief.

In the management of neuralgia about the face, the use of counter-irritants is not advised as excoriation of the skin may occur, followed by scars. Cocain, novocain and eucain have been employed hypodermically, but these should be handled only by experts since the toxic action of cocain, especially, makes it necessary to use it with extreme care.

Fifth.—In the last decade measures have been employed with a view of destroying the fibers of sensory nerves, the periphery of which is affected with neuralgic pains. In this class of agents, one per cent. osmic acid was first introduced. Its advocates claim that pain is successfully terminated by its action. However, the brief period of immunity from pain following its use led to the adoption of an eighty per cent. solution of alcohol, carrying the alcohol into the nerve as it makes its exit from the cranial foramen. These agents should not be employed so as to interfere with the motor nerves in any way, as paralysis might follow.

Sixth.—Nerve stretching has long been known as a potent agent in relieving pain of the greater nerves. This has been especially efficient in cases of contraction or adhesions.

Seventh.—Neurectomy, or excision of portions of a nerve, has been efficacious in certain cases. Resection of the terminal branches of the fifth nerve has been practised with more or less success in effecting the cure of neuralgia. The resection of nerves often includes the removal of a considerable portion. In such cases, the approach and removal of the second and third divisions of the fifth nerve should be made without external incisions.

The last resort in the way of surgical procedure in the treatment of trigeminal neuralgia is the removal of the Gasserian Ganglion.

Having made use of the means at our command, discovered and removed the local irritants, if any there be, or in the failure to discover any local cause of the pain by use of the skiagraph, there still may be present local irritants in the form of neuromata.

First, an effort should be made to control the pain by local applications and internal medication. If no general or local condition can be discovered as the cause of the pain and local applications do not bring relief, the question then to determine is, have we a hypertrophy of the nerve, have we a neuroma or is the condition a general neuritis without discoverable local irritation?

On careful examination of the terminal branches as they emerge from the foramina, enlargements will almost invariably be found in the tissues outside of the foramina. These enlargements or growths may be felt distinctly by digital manipulation. The nerves cannot enlarge within the bony canals.

With such a condition before us, internal medication, local applications or

the injection of osmic acid or alcohol should not be employed as the removal of the diseased nerve is called for.

Alcohol Injection.—While the injection of alcohol may relieve the pain temporarily, the pressure of the enlarged nerve upon its bony wall will, as soon as sensation is re-established in the nerve, cause a recurrence of pain. Following the repeated use of injections of alcohol in cases of nerve enlargement, I have found it necessary to remove the nerve involved and, as a last resort, the Gasserian Ganglion.

The success which has attended deep injection of alcohol by neurologists of great reputation has made it popular. No doubt pain has been controlled for a brief period by these injections, though it had direct origin in some cases from local irritation, but the recuperative powers and vital energy of the nerves are soon re-established and sensation and pain recur.

In certain cases, however, with the injection of alcohol, where the operator has been successful in carrying it into the substance of the nerve, the pain has been removed permanently, but more frequently it recurs. It is advisable to try this treatment before resorting to surgical measures.

In 1910 Weiner, after observing that the injection of a fluid acted upon the nerve by making pressure which stretched its fibers, made use of the following salt solution:

Sodium chloride..	6.00
Calcium chloride..	0.75
Water..	1000.00

Twenty-five cubic centimeters are used at an injection.

The efficacy of this treatment he records as follows: in sciatica fifty-one cases were cured and eight improved; in trigeminal neuralgia twenty-two cases were cured, two improved and two not improved. A comparison covering the injection of alcohol shows that this method gives better results. The benefit derived from the injection of any fluid is the stretching of the nerve fibers. Sterile water alone has been found capable of terminating pain for several weeks. We are, therefore, led to believe that the injection acts mechanically and, as soon as the pressure is relieved by absorption and the nerve contracts, pain returns.

Dr. Hugh T. Patrick[1] reports that, in seventy-five consecutive cases, he has not failed to relieve the pain by the injection of alcohol in a single instance. He has had no fatality and little disagreeable complications. In his seventy-five consecutive cases, thirty-six were between sixty and seventy years of age; thirteen between seventy and eighty; and one over eighty.

Preparation of the Patient.—The patient should be informed of the nature of the procedure and that the operation will not be free from pain. To misrepresent the nature of the operation or to deceive the patient in regard to what he must endure is a practice that cannot be condemned too strongly.

[1] J. A. M. A., Vol. LIII, p. 1987.

To deceive him once is to lose his confidence. To tell him the truth is to enlist his full co-operation in your efforts in his behalf. The use of a local anesthetic oftentimes is advisable or, in extremely sensitive patients, nitrous oxide gas may be employed as the penetration of the needle and the injection into the nerve is unquestionably attended with severe pain.

The merit nitrous oxide has in this treatment is that the patient becomes anesthetized quickly and as quickly recovers from it. The patient may be placed under the influence of the gas while the needle is passed into the nerve. He is then allowed to awake and, by slightly manipulating the needle, it is possible to determine whether one has penetrated the nerve or not. If it has been entered, the patient is put back under the influence of the nitrous oxide and the nerve injected. When the patient again recovers consciousness, the pain will have disappeared entirely, paresthesia be present and the operation proven a success.

The most careful aseptic precautions must be observed in the preparation of the patient, the syringe and the surgeon's hands. The most disastrous

FIG. 818.—Levy-Badouin cannula. (*Binnie.*)

consequences might follow the introduction of septic matter into the deep wound which will here be made. The patient's head should rest firmly against the table or head-rest. He should be seated upright, or lie upon the table with the affected side upwards.

Technic.—To make deep injections into the second and third divisions of the fifth nerve as they emerge from the foramen rotundum and the foramen ovale requires the most thorough knowledge of regional anatomy. A great deal of care must be exercised in directing the needle and injecting the nerve as it emerges from the foramina.

A Levy-Badouin needle with a removable stilette is used for this purpose (Fig. 818). This needle has a sharp point for penetrating the skin and the dense fascia and is provided with a stilette which converts it into a dull-pointed instrument to guard against wounding any vessel which may be in the line of penetration.

The technic of Levy and Badouin is given as follows:

"For the *superior maxillary branch*, to determine the point of puncture, a line is drawn vertically from the posterior border of the orbital process of the malar bone to the inferior edge of the arch of the zygoma (Fig. 819). The needle is to be introduced at a point 0.5 cm. posterior to this line tangentially measured on the lower edge of the zygomatic arch. It is then directed slightly upward and, when introduced to the required depth of 5 cm., it is well in the pterygo-maxillary fossa (Fig. 820).

"At a depth of 2 cm. a bony obstacle, in the form of an abnormal coronoid process, may interfere and, still deeper, an anomalous external pterygoid plate may obstruct. In either event the needle must be inclined forward, but not too far since there is danger of entering the orbit and puncturing the eyeball. It must also be kept well above the spheno-palatine foramen which leads into the nasal fossæ. The skin, cellular tissues, anterior fibers of the masseter muscle and temporal tendon are penetrated in the course of the needle.

"For the *inferior maxillary branch*, the point for puncture is ascertained on the cheek by measuring off 2.5 cm. along the inferior border of the zygomatic arch in front of the descending bifurcation of the longitudinal root of the zygoma (Fig. 819). The needle inserted here to the prescribed depth of 4 cm. arrives at the foramen ovale (Fig. 820) after having passed through

FIG. 819.—Injections for tic. (*Binnie.*)

skin, subcutaneous tissue, the zygomatic insertion of the masseter, posterior portion of the temporal tendon, superior border of the external pterygoid muscle and, lastly, in front of the temporo-mandibular articulation, which latter enables one to avoid the transverse facial artery, the internal maxillary artery and veins and the middle meningeal artery which emerges from the foramen spinosum." (Hecht.)

The needle, with stilette slightly withdrawn from its tip, is introduced to the depth of about 1 cm., when the stilette is pushed forward and the needle carried to the last depth, the stilette withdrawn and the syringe, containing the solution, attached to the needle. The contents of the syringe are then slowly forced out, a minute, at least, being consumed in discharging the fluid. In event of pain the following day, the injection may be repeated.

It is agreed by all authors that the danger to the optic nerve contraindicates the injection of the opthalmic branch. The depth of the penetra-

tion of the needle varies, but to reach the foramen ovale it is necessary to carry it 4 cm. or 1 1/2 inches. When the point of the needle has been carried to the point designated, part of the injection is then made, the needle withdrawn a short distance, 1/5 of a cm., and the injection completed. The quantity of alcohol necessary for injection is from 1 to 2 cc.

The difficulty in approaching the foramen may be very great. It may be necessary to make several efforts to insert the needle before the foramen is entered. In the event that there are supernumerary foramina near the foramen ovale, the needle may enter one of these, in which case the absence of pain indicates that the nerve has not been penetrated. The needle should not be inserted more than 5 cm. as the Eustachian tube might be injured.

FIG. 820.—Injections for tic. (*Binnie.*)

Operators with large experience in the use of alcoholic injections find that no unpleasant effects occur after the treatment. We have only the edematous condition of the tissues, which cannot be regarded seriously. For a few hours following the injection, there may be paralysis. This may last several weeks and, in extremely rare cases, a few months. Neuralgia may be terminated instantly following the operation. As the table shows, however, in some instances it is not so happily controlled (see Patrick's statistics). If the pain persists following the injection, a second, third, or even greater number of injections may be made with a view to its control. Ostwalt of Paris employed several hundred injections, the patients being affected with very severe neuralgia dating back six, seven, nine, ten, thirteen, sixteen and even twenty and thirty years. In one-third of all patients there was a return of symptoms in four to five months. A few subsequent injections, however, are said to have relieved the neuralgia permanently. Very likely many of these cases, if followed up, would reveal recurrences.

Patients, for whom injections have been made and whose pain has been relieved, even though it recurs within a few months, often prefer re-injection to a surgical operation. However, the surgeon's judgment should guide the patient in regard to further treatment.

In the inception of neuralgia, a terminal branch is frequently located as the seat of the pain. Injections into or about this branch may bring relief. For this work a hypodermic syringe may be employed, using a strong needle about 3 to 4 cm. long, and injecting from 1/2 to 1 1/2 cc. of the solution. Alcohol or Weiner's solution may be used, the former being preferable. The terminal branches of the fifth nerve, when affected with neuralgia, are easily discovered by the finger placed in contact with the foramen from which it makes its exit. When injected with the fluid, the nerve will become anesthetized and the pain will cease. The success of the injection will be assured provided the point of the syringe enters the nerve. While the pain may be controlled by carrying the fluid around the nerve, it will become more permanent if the injection be made directly into the nerve. We have always the possibility of injecting a portion or all the fluid into a vein. No doubt this has been done often without serious results, but one should be careful as thrombosis and death may follow.

Treatment of the Terminal Branches.—As the method of deeply injecting the second and third divisions of the fifth nerve has already been discussed, the terminal branches will now be taken up. The first division or ophthalmic branch divides into three terminal parts: frontal, lachrymal and naso-ciliary. The frontal nerve divides into three terminal branches: supra-orbital, supra-trochlear and frontal proper.

The supra-orbital nerve emerges from the supra-orbital foramen or notch and passes directly upward over the frontal bone. It may be felt distinctly as it leaves the notch. The nerve is injected at this point.

The supra-trochlear nerve may be injected just above and to the outer side of the pulley of the superior oblique muscles. It should be injected at the point where it leaves the orbit and turns upward to supply the forehead. Injections into the orbit are contra-indicated because of the edema and the danger of destroying the eye or some of its structures.

Exsection of the terminal branches has long been practised with more or less success in terminating neuralgia.

If the operation for the removal of the terminal branches is accomplished in such a way as to extract the nerve back to the base of the crania, or nearly as far as the foramina from which they emerge from the skull, it is too apparent to require argument that such a procedure would be more efficient in permanently terminating the pain than an injection of alcohol into the substance of the nerve. In the first instance, that part of the nerve in which the pain originates and which may have enlarged under irritation is completely removed. It is apparent, therefore, that the patient is more likely to be free of pain a greater length of time than he would if, in the second instance, the

nerve were injected with alcohol, which does not destroy its structure, but diminishes its sensitiveness or its capacity for transmitting sensation. The pain may be relieved for a time, but not usually permanently.

The injections failing, as they often do, two courses are left open for the eradication of the pain. First, and preferable, is the removal of the branch or branches involved, called distal avulsion; second, the more radical and by far more dangerous operation, the excision of the Gasserian Ganglion.

The order of frequency of pain in the three branches of the fifth nerve is the reverse of their numbering:

1st, the third, inferior maxillary or mandibular branch;

2nd, the second, infra-orbital or superior dental branch;

3rd, the first or supra-orbital branch.

When operating on the maxillary bones or in the performance of operations within the mouth, if of considerable magnitude, it is customary to make external incisions to gain access and to obtain a full view of the field of operation. I hold that these external incisions, followed as they are by the formation of scars, are in a large majority of cases wholly unnecessary.

For example, a patient suffering from persistent neuralgia of the second or third division of the fifth pair of nerves, having undergone medication extending over a period of many months with only temporary relief, is taken by his physician to a surgeon for diagnosis and treatment. The surgeon decides that a nerve lesion exists and that an operation is necessary. The patient is prepared, the operation is proceeded with and an external incision is made in accordance with the location of the pain. If of the inferior nerve, the incision is too frequently made along the border of the jaw, the tissues are reflected up so as to expose the external surface of the mandible, mallet and chisel are made use of, the bone is cut away so as to expose the inferior dental canal and the nerve removed. A saw is sometimes employed instead of a chisel for the purpose of removing the external layer of bone covering the canal. The wound is closed by suturing and the patient is cared for antiseptically until the wound heals.

Author's Operation for Neuralgia of the Third Division of the Fifth Nerve.—For the removal of that portion of the nerve within the mandibular canal an external incision is not necessary, as the operation may be successfully performed within the mouth, proceeding as follows:

A small incision in the mucous membrane should be made downward to the mental foramen (Fig. 821). This incision is made a little below the apex of the root of the second lower bicuspid tooth. The nerve is exposed as it makes its exit from the mental foramen, lifted up with a tenaculum and the branches carefully dissected out of the cheek and lip. After this a bur-shaped drill, propelled by the surgical engine, is employed, the bone cut away from the foramen downward until the mandibular canal is reached. A silver probe of suitable size should be introduced into the canal and carried backward as far as the inferior dental foramen. This may not

always be possible as the canal may be obstructed by a tooth root or spicula of bone which is really the exciting cause of the pain as it makes pressure on the nerve. The object of using the probe is to determine if there is any obstruc-

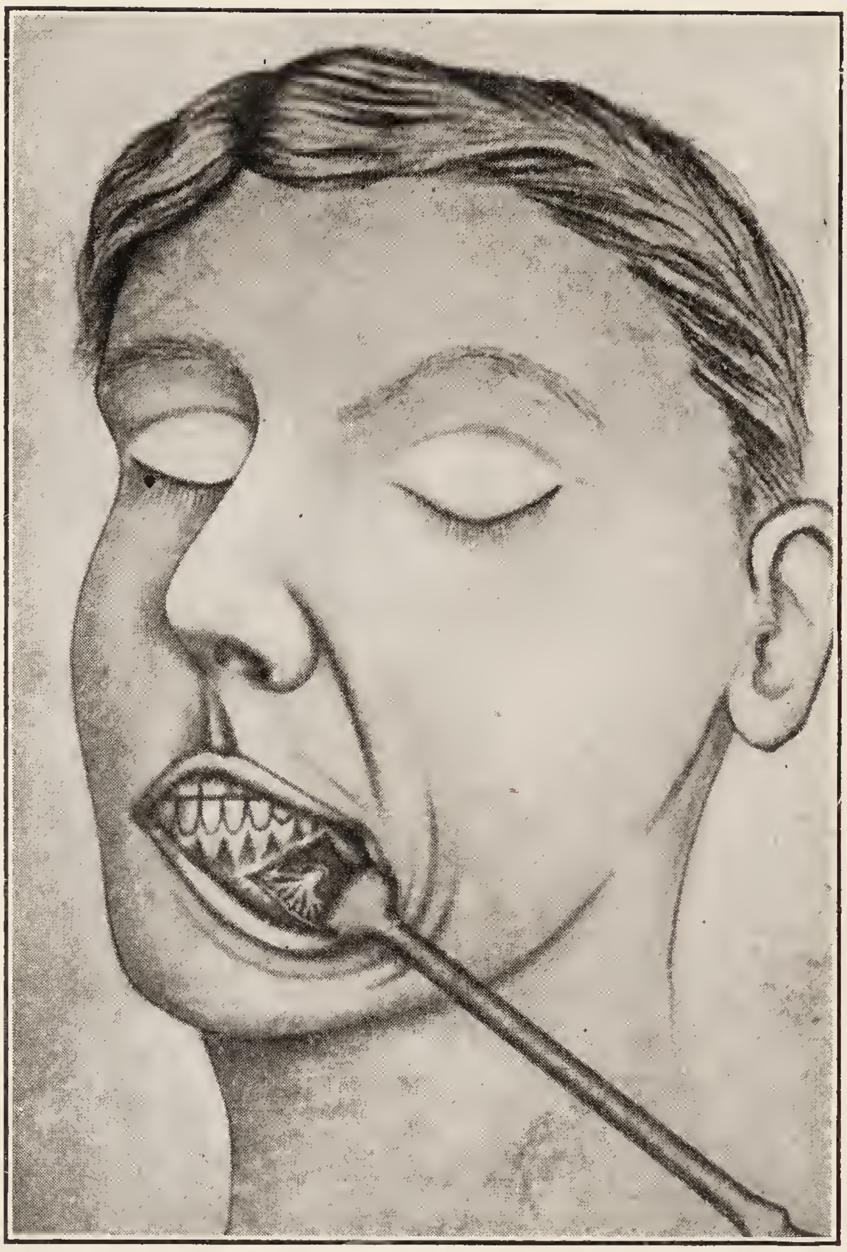


FIG. 821.—Exposure of the mandibular nerve as it emerges from the dental foramen.

tion in the canal. Then a drill, after the form of the Gates-Glidden dental root canal drill (Fig. 822), but much larger, may be carried into the canal and the contents thoroughly removed. Fig. 823 illustrates the

FIG. 822.—A flexible, spiral, hand drill used to remove the mandibular nerve.

barbed broach which is used to remove the nerve from the canal. A larger drill is now employed to ream out the walls of the canal. The small opening in the bone may be plugged with iodoform gauze, which should be

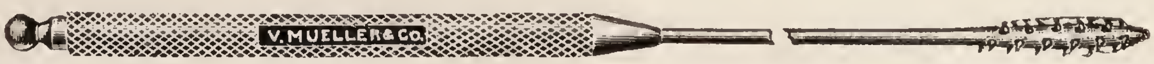


FIG. 823.—Flexible, barbed broach also used to remove the mandibular nerve.

removed forty-eight hours later. The wound should be irrigated and re-packed. This should be kept up about ten days, when further packings

are uncalled for. The wound in the mucous membrane will then close very promptly. Fig. 824 illustrates a section of the mandible. The external plate of the bone has been removed and the canal exposed to view. To pass the drill into the canal, it is necessary to introduce the bur at the mental foramen, cut downward and remove sufficient bone to get in direct line with the canal. When the drill is introduced it may be carried backward and out of the inferior dental foramen, where it is distinctly felt beneath the mucous membrane on placing the forefinger on the lingual surface of the ramus of the bone. The drill should not penetrate the mucous membrane.

The object of this operation is to clean out the nerve and to prevent its re-development.

In order that the nerve may not re-develop, as it is inclined to do, the canal wall should be drilled so as to freshen the surface of the bone, thus caus-

Fig. 824.—Mandible, showing the mandibular canal. The alveoli of a molar tooth approaches the mandibular canal. Irritation at the apices of the roots may be the starting point of neuritis, or an abscess forming there would likely discharge into the canal. The pain following would be intense.

ing an exudate and the consequent filling of the canal with bony tissue. Experience has taught us, however, that the canal does not always fill with osseous tissue and the nerves will be reproduced in certain cases. To avoid this, the canal may be filled tightly with gutta percha, moulded into it while soft, thus preventing the development of nerve tissue.

I am of the opinion that there is no more reason for making an external incision for the removal of the nerve within the mandible than there would be to make an external incision through the cheek to gain access to the third molar tooth for the purpose of entering the pulp chamber.

The time has passed when making incisions on the face will be tolerated by intelligent people when the same may be made better within the mouth.

It is unnecessary to emphasize the importance of making a careful diagnosis. To undertake the treatment of neuralgia without determining the presence of abnormalities connected with the teeth would be to grope in the dark regarding the origin of the pain.

When neuralgia affects the *lingual branch*, which is rare compared with the frequency of the pain in the mandibular branch, it becomes necessary to expose the nerve and remove a section of it. To do this various methods have been employed. Keeping in mind the importance of operating with a view to leaving the parts in as nearly a normal condition as possible, and the serious objections to making external incisions whenever they may be avoided, we see at once that some of the methods of authors named are not called for. It will also be seen that measures advocated by some enable the surgeon to make a thorough operation, accomplishing all that he is capable of doing without making external incisions and thus causing unsightly scars, disfigurements and sometimes absolute deformities. It is the surgeon's duty, therefore, to choose a method of procedure which will enable him to do his work without leaving his patient permanently disfigured.

Sonnenberg and Lucke operated as follows: The patient was placed with the head in Rose's position, so as to afford the operator a satisfactory view of the parts. The incision was made on the internal surface of the mandible, forming an angle corresponding to the angle of the ramus to the body of the bone. The inner surface of the ramus of the bone is thus exposed. The periosteum together with the internal pterygoid muscle are lifted upward and backward until the bone, the inferior dental foramen and the mandibular nerve which enters it are exposed to view. The nerve is then separated from the accompanying artery, picked up with a tenaculum or fine hemostatic forceps and pulled downward and backward. The surgeon may then pull the nerve a considerable distance outward from the mandibular canal and also pull it downward. Using care to make traction in both directions, he will be able to form a fairly large loop of nerve tissue. It is then drawn out of the canal as far as possible and cut off. Traction may now be made downward and backward from the foramen ovale, thus securing a considerable portion of nerve tissue within the foramen.

This method has its advantages, since the small scar that is left from the incision is made in the shadow line and is not especially conspicuous. I would recommend that the skin be reflected forward and upward before the incision is made so that no adhesion forms between the scar and the periosteum during the process of healing. Such adhesions prevent the mobility of the skin, thus leaving a more conspicuous scar than will follow the observance of the precautions I have mentioned.

Kuhn and Brunz' operation consists in making a curved incision externally along the posterior margin of the ramus of the jaw from the ear to the anterior border of the insertion of the masseter muscle. The parotid gland is lifted backward and upward. A saw is then employed, the angle of the jaw

removed when the nerve is to be observed in the open mandibular canal. It may be picked up with a tenaculum, drawn backward and removed.

This operation is a departure from the principles I have endeavored to promulgate, viz., to so operate as to sacrifice no tissues which may be preserved to the advantage of the patient; in other words, to so operate as to leave the parts in as nearly a normal condition as possible. In this operation, especially in thin patients, the loss of the angle of the jaw must necessarily leave a conspicuous deformity.

Velpeau and Linnhert's method consists in making an incision over the external surface of the ramus of the bone about 1 cm. from the lower and distal border and from 3 to 4 cm. in length. The fibers of the masseter muscle are divided lengthwise, the bone denuded of the periosteum, and mallet and chisel employed to remove the wall of the mandibular canal, thus exposing the nerve and artery. With a tenaculum the nerve may be removed easily and excised.

Kronlein's method, the retro-buccal method, is still practised by some surgeons. A transverse incision of the cheek is made, beginning 1 cm. from the angle of the mouth and ending 1 cm. in front of the lobule of the ear. This incision calls for the division of the anterior two-thirds of the masseter muscle and the excision of the coronoid process. The steps necessary for the exposure of the mandibular nerve and for its removal call for two extensive incisions, necessarily followed by disfigurement of the face. While this method enables the surgeon to reach the base of the skull for the resection of the nerve, other methods, which do not leave extensive scars, are equally effective in arresting pain.

The Mikulicz method is a more radical procedure. An extensive incision is made along the sterno-cleido-mastoid muscle from the mastoid process as far as the level of the great cornu of the hyoid bone. It is there curved upward to the anterior margin of the masseter muscle, 1 1/2 cm. beyond the margin of the mandible. Thus the bone and the cervical portion of the parotid gland are exposed. The bone is sawed through by the step method.

The extensive incisions in the face; division of the bone and ligaments; the separation of the greater portion of the masseter muscle; the injury to the temporo-mandibular articulation; detaching the insertion of the internal pterygoid muscle and the injury to the external pterygoid muscle; the almost invariable rupture of the mucous membrane of the mouth; the danger of general infection by reason of the opening, which is so likely to occur within the mouth and the wound generally; the possibility of failure of union of bone when once wired; the division of the mylo-hyoid muscle, followed by its retraction; deep scars and adhesions to the bone—all mark this operation inexpedient and uncalled for.

The late Professor Garretson made an incision along the border of the mandible, reflecting the tissues upward, and with the engine bur removed that portion of the external plate which covers the canal, then seized the

nerve, pulled it down and excised it. In the light of modern methods, this operation is unnecessary.

Professor Pancoast operated by opening the cheek, excising the coronoid process, and thus gaining access to the nerve.

Agnew also opened the cheek, trephined the bone over the mandibular canal 1 cm. distal to the anterior border of the masseter muscle, and thus reached the nerve.

To get access to the nerve through an external incision, the Cryer operation is the most desirable. His incision is made through the substance of the masseter muscle and sufficiently low to avoid division of the facial nerve.

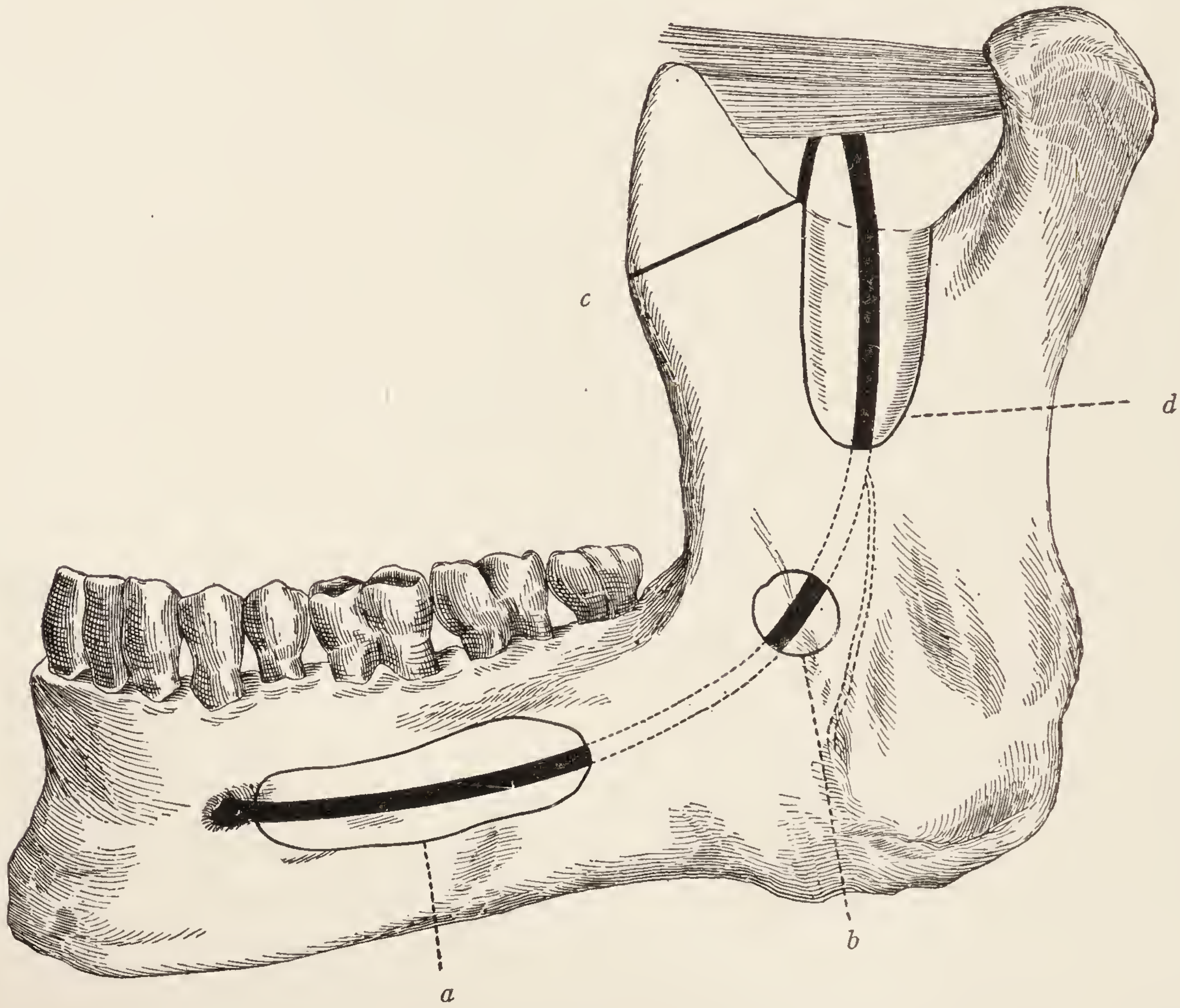


Fig. 825.—Operation for the excision of the mandibular nerve. *a*, Garretson operation; *b*, Agnew operation; *c*, Pancoast operation; *d*, Cryer operation. (*Marshall after Cryer.*)

The periosteum is denuded from the bone, the soft parts lifted upward and, beginning at the base of the sigmoid notch, in close proximity to the neck of the condyle, a strong engine bur cuts downward one inch to a point corresponding to the position of the inferior dental foramen.

The point of the bur is again placed in the sigmoid notch, nearer the coronoid process, carried downward to the depth of the first incision, and the section of bone is removed (Fig. 825). This notch may be deepened by the use of the bur, if necessary, until the opening in the bone exposes the nerve to view. It is then picked up and drawn upward first and then downward, the object being to remove the greatest amount of nerve tissue possible.

If it is intended to remove the lingual nerve also, by careful manipulation,

going a little further inward with a blunt instrument, the nerve can be picked up and a section removed from it.

It will not be difficult to determine the difference between the lingual and the mandibular nerves. The latter is more limited in its movements. In making an effort to move it forward, it is found to be nearly fixed in its position, while the movement of the tongue permits the lingual nerve to be picked up with considerable freedom.

In this manner the nerve is exposed nearly as far as the foramen ovale. By drawing it down, gradually twisting it and placing forceps over forceps as a sailor pulls a rope, the greater part of the trunk of the nerve may be removed as far back as the foramen ovale, and sometimes even beyond. The wound is sutured and dressed aseptically.

As recommended before, whenever it becomes necessary to make an external incision for the removal of this nerve, the Cryer operation is especially commended. It does not disturb the temporo-mandibular articulation nor interfere with muscular function. It does not leave as great a scar, since the incision is made lengthwise of the fibers of the masseter muscle, and the skin unites kindly. Moreover, less shock occurs than from any of the more extensive operations proposed.

The Lingual Nerve Operation.—The Cryer operation above described, for exposing the mandibular and the lingual nerves by making an opening through the ramus of the mandible, is the most expedient method when external incisions are made.

Keeping in mind the desirability of avoiding external incisions, the surgeon may accomplish his work in removing the lingual as well as the mandibular and the infra-orbital nerves intra-orally by employing Roser's operation.

To remove the lingual nerve without external incision is a simple operation: The tongue is seized by forceps, carried forward and diverted to the side opposite the one from which the nerve is to be removed. This will enable the surgeon to see the shining nerve through the mucous membrane and to make an incision over it, when the nerve may be picked up, drawn downward and divided.

In Roser's method of removing the nerve, he states that if the widely opened mouth does not offer sufficient access, the cheek must be divided transversely. With suitable retractors, the external incision probably will not be necessary at all.

Parvicini's method of exposing the lingual and the mandibular nerves is commended since it may be done without dividing the external tissues of the face. The mucous membrane is incised along the ascending ramus of the mandible just back of the third molar tooth. The internal pterygoid muscle is elevated and, with a blunt instrument, the nerve is exposed to view.

Author's Operation for Removing the Second Division of the Fifth Nerve.—The second division of the fifth pair of nerves, or the infra-orbital

branch, frequently requires surgical operations in the treatment of trifacial neuralgia. It has been customary, in performing these operations, to make external incisions for the purpose of entering the infra-orbital foramen and excising the nerve. I have found that equally good results may be obtained by raising the cheek with a retractor and making an incision over the cuspid tooth at the folding of the mucous membrane (Fig. 826). The soft parts are dissected up and the nerve seized as it leaves the infra-orbital foramen. The branches distributed to the cheek, ala of the nose and upper lip are care-

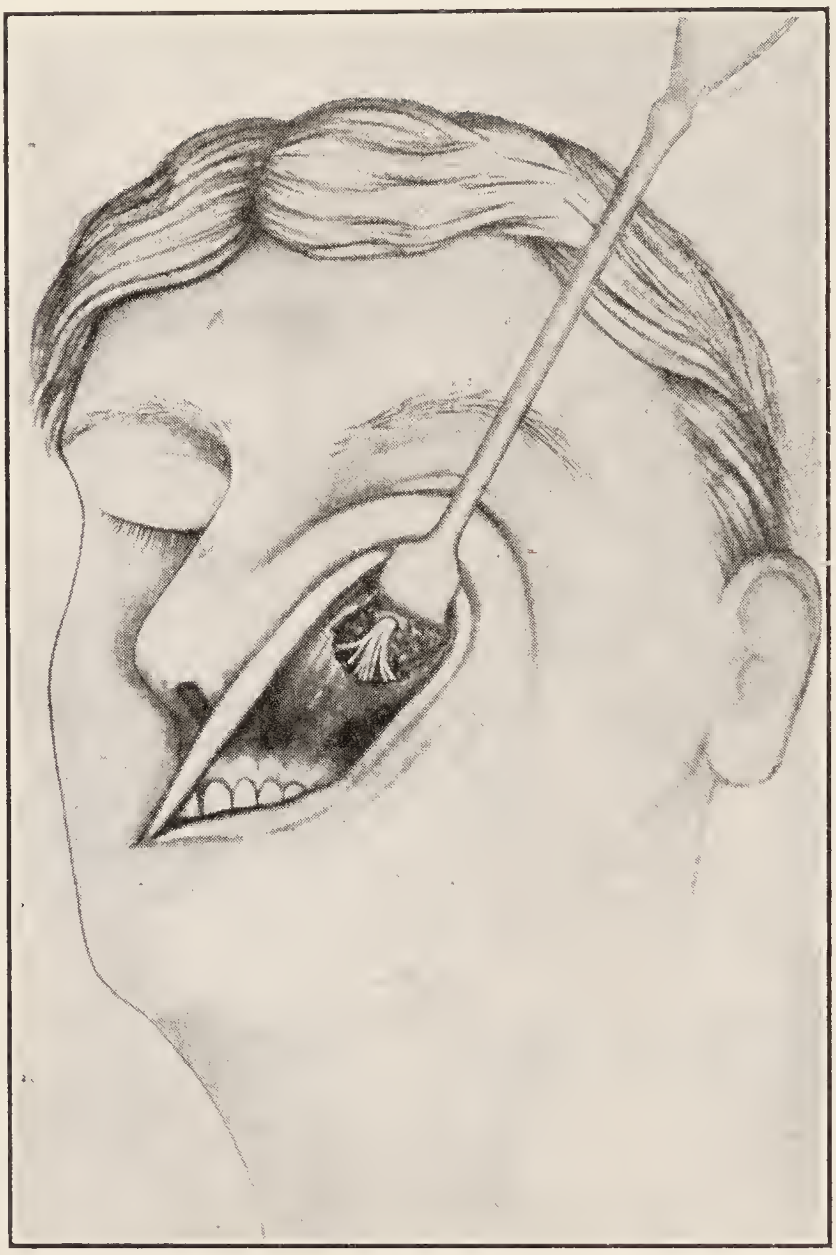


Fig. 826.—Infra-orbital foramen exposed by retracting the cheek. The nerve is in view.

fully dissected out, after which the infra-orbital canal is enlarged by means of a drill. The nerve is seized, drawn forward and divided. Thus we get the greater part of the nerve and accomplish the same end that may be gained by making an external incision.

I have been doing this operation for the removal of the infra-orbital nerve during the past twenty-five years. I am satisfied that the results obtained are equal to those which follow making extensive external incisions, as previously described.

Aseptic gauze should be placed in the wound and allowed to remain for forty-eight hours, after which it should be removed and a smaller piece

inserted in the lip of the wound so that union of the parts may take place promptly. The wound is self-draining and the operation is followed by immediate union. No evidence of the operation is left in the formation of scar tissue.

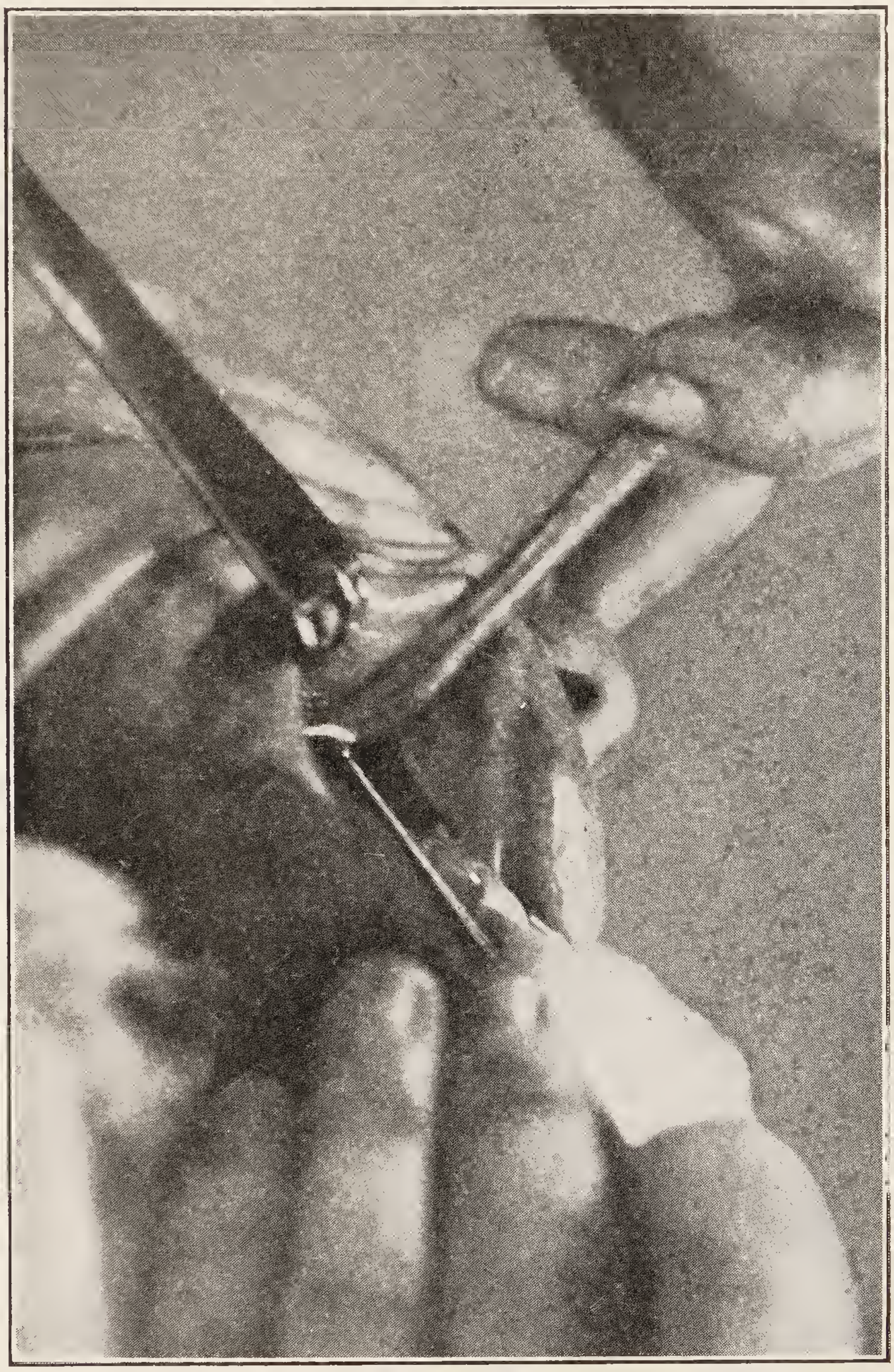


FIG. 827.—Illustrating the method of removing the infra-orbital nerve intra-orally.

FACIAL PARALYSIS

Introduction.—Facial paralysis is also known as Bell's palsy. The paralysis may result from lesions in the cortex, the nucleus or along the course of the nerve. Owing to this fact, it is not feasible to describe facial paralysis in general. Each subdivision is, therefore, taken up separately.

In reviewing the work done on this subject, it is a noticeable fact that each author applies a different terminology in describing facial paralysis. I have come to the conclusion that the divisions used by Dieulafoy[1] are the best:

[1] Text-book of Medicine, Appleton & Co.

1. Paralysis of peripheral origin.
2. Paralysis of intra-temporal origin.
3. Paralysis of bulbar origin.
4. Paralysis of cerebral origin.

Fig. 828.—A groove director in contact with the gingivo-labial groove. The point lies just below the infra-orbital foramen. This illustrates the close proximity of the oral mucous membrane to the foramen. The ease with which the foramen may be approached by the intra-oral route should preclude external incisions.

Paralysis of Peripheral Origin.—In this form of paralysis, the portion of the nerve which has emerged from the stylo-mastoid foramen is involved. This part of the nerve supplies the muscles of the skin, neck, face and anterior portion of the scalp. The principal etiological factor in this form of paralysis is exposure to cold or draft. The history given by patients most frequently is

that they were sitting by an open window or riding in a train next to an open window. Exposure to cold, damp air is also a frequent cause. Tumors, injuries in which the nerve is severed and operations about this nerve are less frequent causes of paralysis. In new-born infants the use of forceps in the delivery may produce paralysis by the continued pressure of the blades. Syphilis is a rather frequent cause. It is one, however, which is often overlooked.

Facial paralysis usually makes its appearance very suddenly. It is rare that both sides are affected at the same time. The face, on the side affected, is motionless and devoid of wrinkles and expression. On requesting the patient to laugh or speak, the signs become more prominent. The eyelids cannot be closed and the lower lip is seen to droop. The mouth is changed noticeably, the angle on the affected side being lower. The patient's speech is interfered with somewhat, whistling is impossible and chewing the food on that side of the face becomes exceedingly difficult. This is due to the fact that the patient is unable to remove the particles of food which collect between the cheek and the jaw. On protruding the tongue, it deviates to the affected side.

Paralysis of Intra-temporal Origin.—In this form of paralysis the lesion occurs in that portion of the nerve which is included in the temporal bone. The etiological factors concerned in this form of paralysis have particularly to do with the petrous portion of the temporal bone, thus fractures, tuberculosis, otitis media and syphilis are the usual causes. Exposure to cold is also a frequent cause and is said to be due to the fact that the inflammation set up in the nerve causes it to swell and be compressed by the bony walls.

Paralysis of Bulbar Origin.—In this form of paralysis the limbs are usually affected. This is known as crossed paralysis. The face is involved on the same side as the lesion, while the limbs on the opposite side are paralyzed. The principal causes of this form of paralysis are cerebral tumors, hemorrhage and softening of the brain. As the oral surgeon rarely has occasion to deal with this form of paralysis, further details are omitted.

Paralysis of Cerebral Origin.—This form of paralysis is divided into two varieties by Dieulafoy: the central and the cortical. The central lesions are hemorrhage, softening of the brain and tumor formation. The paralysis of the face occurs on the same side as the hemiplegia of the limbs. The inferior portion of the face alone is affected. In paralysis of cortical origin, the face is affected to the greatest extent, while the monoplegia or aphasia varies according to the site and extent of the cortical focus.

Prognosis.—Prognosis, as a rule, is favorable, recovery taking place in from two to three weeks. When the reaction of degeneration is present, the prognosis is unfavorable. It is in these cases that contractures of the face appear.

Treatment.—Little can be done to alleviate this condition. The paralysis usually runs a more or less definite course and, in the majority of cases, is

self-limited. In case the lesion is due to syphilis, the internal administration of anti-syphilitic medication will soon clear up the condition. Faradization is indicated, but care should be taken not to over-stimulate the part as contractures may result. If, after some time, the paralysis does not pass away, nerve anastomosis may be undertaken. The spinal accessory or hypoglossal nerve may be united to the divided peripheral end of the facial nerve. When this is done, the facial movements will return slowly, but as a rule they are associated with those of the shoulder or tongue. It is by education that this is overcome.

CHAPTER XXXVIII

THE SALIVARY GLANDS

The salivary glands are six in number: two parotid, two submaxillary and two sublingual. The secretion of the parotid differs somewhat in composition, as well as in the process of formation, from that of the other two sets of glands. The secretion of each is alkaline in reaction and contains a digestive enzyme which acts more or less on the carbohydrates, converting starch into sugar. The chief function of these secretions is to lubricate the buccal surfaces and to soften the food in the process of mastication. This is augmented by the secretion from the numerous mucous and serous glands in the submucosa of the buccal cavity.

THE PAROTID GLAND

Embryology.—"In the embryo of about 8 mm. a slight furrow may be observed in the floor of the groove which connects the lip groove of the upper and lower jaws at the angle of the mouth, and may be known as the cheek groove. In the later stages this furrow deepens and eventually becomes closed in to form a hollow tubular structure which, in embryos of 17 mm., has separated from the epithelium of the floor of the cheek groove except at its anterior end and has become embedded in the connective tissue of the cheek. This tube is readily recognizable as the Parotid gland and Stenson's duct, and from the latter, as it passes across the masseter muscle, a pouch-like outgrowth is easily formed which probably represents the socia parotides."[1]

The Parotid Region.—The parotid gland is the largest of the salivary glands and is located in the parotid fossa, a definite space behind the angle of the mandible. Portions of the gland extend as far back as the sterno-cleido-mastoid muscle and anteriorly well over the posterior border of the masseter muscle and upwards to the zygoma. The gland is invested with a strong fascia, which is a direct continuation of the deep cervical fascia. One fold passes anteriorly over the gland and is attached above to the zygoma, posteriorly to the cartilaginous meatus and the anterior border of the sterno-cleido-mastoid muscle and in front to the masseter muscle. The deep layer is not so strong and is attached to the styloid process forming the stylo-maxillary ligament. It is further continuous with the fascia of the pterygoid muscles. Thus the cavity in which the parotid gland is located is closed below and open above. This point should be taken into consideration in

[1] McMurrich.

infections of the gland and will also explain why post-pharyngeal abscesses cause a marked swelling in the parotid region and often discharge spontaneously. This closed and unyielding fascia accounts for the severe pain in acute swellings of the gland.

The gland lies in direct contact with the temporo-mandibular articulation and, in acute abscesses, the posterior fascia may give way and the abscess discharge into the joint. A similar condition is encountered in regard to the cartilaginous meatus as it lies beside the gland, being separated by fascia only.

The facial nerve, as it leaves the stylo-mastoid foramen, passes forward into the substance of the gland and there divides into two large branches: the temporo-facial and the cervico-facial. With care the nerve may be dissected out, its integrity preserved and its function maintained. The nerve must be handled cautiously so as to avoid compression or injury. In some isolated cases the nerve is fairly free and in removal of the gland it is well to investigate its relation, as it may be possible to sever the nerve, protect it and subsequently re-unite it.

The external carotid artery also lies in close relationship. It enters the gland from in front and to the inner side, passing backward and outward. It comes to the surface near the condyle of the mandible where it bifurcates into its two terminal branches.

It will thus be seen that the parotid gland is closely associated with two important anatomical structures.

Malformations.—Congenital defects of the parotid gland are comparatively rare. There may be an absence of one or both glands, and often in this condition aberrant parotid glands are found, which are usually located along some part of the normal course of the duct—often at its orifice—lying just under the buccal mucous membrane. Congenitally small glands may be found.

Injuries to the Parotid Gland.—The position of the gland makes it liable to frequent injuries. The most common form of injury is a simple contusion due to direct violence, as a blow on the mandible. This may cause merely an acute swelling, which subsides in a few days without any after effects. If the blow is especially severe, hemorrhage may occur into the substance of the gland and the fascial capsule may be torn. If, in connection with this, there is a laceration of the skin, a salivary fistula may result. This type of fistula may close spontaneously in the course of a few days to a week, or its closure may be accomplished with great difficulty.

Trauma seems to be an important predisposing factor in the subsequent development of certain diseases of the parotid gland. In acute inflammation, the bacteria pass either through the skin, by way of microscopical openings, or up the duct. The trauma preceding causes a lowering of the resistance of the gland sufficient to enable the bacteria to thrive. Such conditions as tuberculosis and even sarcoma can often be dated back to an injury.

Gun-shot or stab wounds may lead to severe hemorrhage into the gland or into the fascial capsule. This is especially true when either the external carotid or one of its branches is severed. Some branch of the facial nerve may be injured, leading to paralysis. Salivary fistula is not at all infrequent, especially when slight infection takes place following an open skin wound. A temporary facial paralysis may occur several days after a severe blow to the parotid gland. This type of paralysis usually passes off in a few days to a week and is, unquestionably, due to an infective neuritis, the infection being of such a low grade as not to cause much local disturbance.

Treatment.—Simple contusion with acute swelling should be treated by rest to the parts and hot applications. In case the patient comes under observation early, cold applications may be more beneficial. In open wounds of the parotid gland, the parts should be cleansed carefully, all bleeding points ligated, and the fascial capsule sutured to avoid a possible salivary fistula. Before the skin is closed, one should determine whether the facial nerve has been severed; if so, an attempt should be made to approximate the ends. Care should be taken to get a neat apposition of the skin edges so as to avoid an unsightly scar. A horse-hair subcuticular suture often can be used to advantage.

INFLAMMATION OF THE PAROTID GLAND

Primary Parotitis.—*Etiology.* The infecting organism may enter the gland by direct inoculation as in an open wound. The extent of the infection depends both on the virulence of the organism and on the amount of contusion of the tissues. Individual resistance to certain infections may have a rôle. It is also a well-known fact that an ascending infection quite often takes place after an injury to the gland. There may be sufficient destruction to enable organisms present, or those which may ascend the duct, to multiply. Infective material may be carried directly to the gland, as in gun-shot or stab wounds. Mouth infections predispose to parotitis, especially the more virulent type of infection in a patient below par.

Obstruction of Stenson's duct or partial stenosis often leads to infection. The process here is usually a primary inflammation of the duct and a subsequent involvement of the gland. The question of calculus is somewhat in doubt as to whether the infection is not primary and the formation of a calculus secondary.

Secondary Parotitis.—Acute infectious diseases, such as scarlet fever, typhoid fever, measles and meningitis, are frequently followed or accompanied by parotitis. The parotid involvement in these conditions often comes late in the course of the disease, and a rise in temperature with pain on widely opening the mouth may give the first warning.

In certain acute abdominal conditions, such as appendicitis, cholecystitis and acute abscess, one encounters an acute infection of the parotid gland occasionally. Frank believes that this is an ascending infection and not a

metastatic affair. Hanau and Pilliet, by making microscopical observations in these cases, found the infection spreading from the central duct to the periphery. Girode made cultures from the gland in these cases and found them identical with cultures from the mouth and not of the type of the abdominal infection. Injury to the gland during the administration of an anesthetic may have some bearing on the case.

Treves states that there are lymphatic glands in the substance of the parotid gland as well as in the capsule, consequently a lymphadenitis may lead to an infection of the parotid.

The parotid gland may become infected in the course of a pyemia or a septicemia. However, this condition is comparatively rare.

Pathology.—In direct inoculation of the gland with infective material, the process begins about the wound or point of inoculation and spreads. If there is sufficient drainage, it does not extend any distance, but should the wound of entrance become occluded, then an abscess may form. In ascending duct infections, the process begins in the central duct, spreading to the periphery and to the interlobular tissue. When the infective organism is carried to the gland by the blood-stream, the inflammation begins about a vessel and spreads. Due to the dense capsule of the gland, the infection tends to remain localized or extend upward. Streptococcic infections are accompanied by severe edema of the tissues about the gland and there is rarely any pus formation. Mixed infections usually cause an early destruction of the tissues and abscess, even though there may be no fluctuation. If left untreated, the abscess may perforate into the temporo-mandibular articulation, into the external auditory canal or may extend upwards beneath the zygoma. Many of the cases "point" externally and will rupture spontaneously if left alone.

Symptoms.—The onset is usually rather sudden, with pain and tenderness over the gland. The pain is increased with motion of the mandible. A swelling soon appears in the characteristic location, filling out the parotid fossa. This may also be preceded by rigors, nausea and malaise. As the process advances, the skin becomes red and the patient complains of a throbbing sensation. With this there is usually a rise in the temperature and the pulse becomes quickened; in fact, the patient may be profoundly septic in some cases. The blood count may show a moderate polymorphonuclear leucocytosis.

Diagnosis.—This condition must be differentiated from the epidemic type of infection or mumps. The pain is more severe and usually unilateral. Mumps rarely ever lead to suppuration and run a more or less definite course with a tendency to orchitis in the male and mastitis in the female. Such conditions as cysts and neoplasms are more slow in growth; there is much less pain and an absence of the septic symptoms unless there is a secondary infection.

Treatment.—As a prophylaxis, the mouth should be kept especially clean after an injury to the parotid gland or after a surgical operation of any kind. Following an injury, where the skin has been broken, the parts should be cleansed aseptically.

Early in a case hot applications over the gland, with frequent cleansing of the mouth with mild antiseptic solutions and proper attention to the teeth, along with forced elimination and rest, may lead to resolution. If the condition does not subside promptly, it is always best to drain; the incision should be so made as to cause as little disfiguration as possible after healing takes place. This incision should be carried through the skin and fascia only and then the gland substance entered with a blunt instrument so as to avoid injury to the facial nerve or to the large blood-vessels. Hot applications should be continued until signs of acute inflammation have disappeared. In the streptococcic type of infection, the operative procedure should be more radical. Multiple incisions should be made, free drainage being the essential element in the cure.

EPIDEMIC PAROTITIS—MUMPS

Mumps is an acute contagious disease, characterized by an inflammation of the parotid gland and, at times, of the other salivary glands. There is a marked tendency toward a complicating orchitis or mastitis.

Etiology.—This disease is found very extensively among school children and in institutions. Males seem to be more susceptible than females. It is highly contagious, the virus probably being disseminated by the secretions of the upper respiratory tract.

In 1893 Laveran and Catrin obtained a diplococcus from the parotid gland. This same organism was also isolated from the testicle in a case of orchitis. Herb, in 1909, describes this same organism more in detail and cites it as the probable cause of mumps. It has been isolated from the parotid gland, testicle, cerebro-spinal fluid and blood-stream in epidemic parotitis. It is a gram positive diplococcus, at times occurring in chains. It is non-motile, has no capsule and grows very slowly on ordinary culture media. On experimental injection into animals, it produces a non-suppurative parotitis and, at times, an orchitis.

Pathology.—Since the disease is rarely fatal, but little work has been done on the essential pathology. The gland is the seat of acute inflammation which has a tendency to infiltrate, then recede and rarely ever to suppurate. One gland is usually affected first, but as the inflammation recedes there the other gland may become infected or the patient, if a male, may develop an orchitis. The testicle swells quite rapidly and is a seat of great pain due to the pressure from the rapidly increasing edema. The inflammation in this organ is diffuse, affecting all parts practically alike. There is a stronger tendency for this gland to break down and suppurate. Frequently after the orchitis subsides the testicle undergoes atrophy, leaving the patient sterile,

providing the disease has been bilateral. In the female ovaritis or mastitis may complicate, although this is by no means as frequent as orchitis.

An acute nephritis may develop, whether due to an acute toxemia or to the direct action of the organism is not definitely known.

Symptoms.—The incubation period is from one to three weeks. The disease is ushered in at times with a chill, or chilly sensations, followed by a temperature ranging from 100° to 104° F. The patient complains of difficulty in opening the mouth widely and soon notices a swelling in the parotid fossa. This increases in size quite rapidly and often is the seat of considerable pain. The skin over the gland may become edematous. Other salivary glands may be acutely inflamed at this time, especially the submaxillary, and complications such as orchitis may develop. Quite frequently, when the swelling in one gland begins to subside, the opposite gland will also become similarly affected. As a rule, an uncomplicated case of mumps runs a rather benign course, lasting from five to seven days. Occasionally the patient becomes profoundly toxic, complaining of severe headaches, nausea and vomiting, diarrhea, or he may become delirious. In these cases, where the toxemia is severe, complications are more liable to occur and are usually of a more violent type.

Such conditions as nephritis, with uremic convulsions and pericarditis have been encountered, but are rare. Orchitis usually occurs during the height of the disease, makes a sudden appearance associated with a rising temperature, often with a distinct chill and acute pain in the testicle. The patient may become very toxic, even delirious. The testicle is very tender and painful. This complication usually subsides in from five to eight days.

Treatment.—Rest in bed is, by all means, the essential element in the treatment of mumps. It lessens the danger of complications and shortens the course of the disease. Isolation should last for three weeks from the onset. If the pain in the gland is severe, hot applications of lead-water and opium are often soothing. It has been the author's experience that an alcoholic solution of menthol (dram 1 to ounces 4) and an equal amount of water, applied to the gland on flannel and covered with oil silk, gives the most relief.

The mouth and nose should be cleansed frequently with some mild antiseptic alkaline wash. The patient should take large quantities of liquids, such as a pint of lemonade, containing two teaspoonsful of cream of tartar, two or three times daily. If the temperature is high, tepid water sponging may be employed. Free catharsis is essential. When an orchitis occurs, hot applications should be applied early. Good results are often obtained by painting the scrotum with a twenty per cent. mixture of guaiacol in glycerin. The part should be suspended and the patient put completely at rest until all signs of inflammation have disappeared.

CHRONIC INFLAMMATION OF THE PAROTID GLAND

Chronic inflammatory conditions of the parotid gland may be divided into two classes: chronic diffuse parotitis and the infective granulomata.

Chronic Diffuse Parotitis.—Etiology.—Chronic diffuse parotitis may be an end result of one or more repeated attacks of acute parotitis or may be a process which gradually appears, having never had the characteristics of an acute inflammation. In the latter case it is often associated with and is unquestionably caused, at times, by a low-grade infection in the mouth which has lasted for some time. The infection ascends the duct and is due, possibly, to the virility of the organism or the lowered resistance of the patient. There is no sudden inflammatory explosion, but a slow reaction manifested by infiltration and an increase of the interstitial tissue of the gland. Such conditions as foreign bodies in the duct, calculus or fistula, are also causative factors.

Symptoms.—If the condition follows an acute parotitis, the process is a continuation of that disease. Instead of subsiding, the gland will remain enlarged, often irregualr in contour and more or less tender to touch. Frequently there is a gradual reduction in the amount of saliva from the gland in question, due to the disappearance of the glandular structure, the latter being replaced by fibrous tissue. In the second type, the gland gradually increases in size. At times the skin becomes adherent, although this is by no means constant. Early but little pain is experienced; later, when the swelling is of sufficient size, there may be peculiar neuralgic pains and some tenderness. This process may terminate in one of four ways:

1. Fibrosis of the gland. The glandular structures are replaced by scar tissue which contracts, and if the infection is overcome at this stage the gland may decrease in size below normal, but if the infection persists, the tumor remains or even becomes larger. Quite frequently it is the seat of sharp, piercing pains and may be tender at times. This type may lie dormant for a long time and, later, assume one of the other stages.

2. Abscess formation. Portions of the gland may, after considerable time, break down and form an abscess. This may be considered an acute exacerbation of a chronic condition. Depending on the nature of the pathological process, there may be one or many of these secondary abscesses. They may form and lie dormant for a long time, advancing and receding. The wall eventually breaks down and the abscess discharges. If the condition has existed long enough, the contents of the abscess may be sterile.

3. Cystic degeneration. Often it is impossible to differentiate this form of disease from low-grade abscess formation.[1] Usually the inflammatory condition has existed a longer time. The infection is of much lower virulence and usually localized to a certain portion of the gland. In this case the cyst

[1] For true cysts of the parotid, see chapter on Cysts.

will be single. At other times multiple small cysts may appear. The diagnosis, except in isolated cases, is not made before operation, the symptom complex having nothing specially characteristic of the nature of the disease.

4. Calcareous degeneration. Due to the long-continued presence of infection of low grade, just as in gall-stones or kidney stones, causing an irritation and subsequently the presence of a foreign body in the form of particles of dead tissue, there is deposited calcium salts. The line differentiating true calculi from this disease is vague. The process usually is more diffuse and frequently associated with abscess formation. With the deposition of calcium salts, the tumor becomes very hard and frequently tender to touch. Often this hastens the formation of an abscess.

Diagnosis.—Frequently chronic inflammations of the parotid gland are confused with neoplasms and the diagnosis only made on the operating table or by the pathologist after the gland has been resected. Consequently, when in doubt, a part of the tumor should be examined microscopically. Even with this precaution there is possibility of error.

Treatment.—If the tumor is not large and causing any trouble, it should not be operated upon. The patient may overcome the infection eventually and the gland undergo fibrosis. If this does not occur, hot applications may be applied for about a week. After this the parts may be massaged carefully. In event that this does not produce the desired result, the skin may be painted with tincture of iodin, which often reduces the enlargement.

In the presence of an abscess, the pus should be evacuated. Occasionally this can be accomplished through the mouth. It is often possible to drain the parotid gland by means of a small trochar or exploring needle. This is inserted through the skin and the pus withdrawn. In draining through the skin, the importance of the seventh nerve should be kept in mind and a small incision may be made about opposite the lobe of the ear. The gland is then punctured by the artery forceps and drainage mantained by means of a gauze strip. If degeneration of the gland occurs or an enlargement sufficient to cause a deformity, it should be removed.

In any case, the mouth should have rigid attention. Foreign bodies in Stenson's duct should be removed or, in stenosis, it should be dilated. The general condition of the patient should receive attention and proper elimination instituted.

INFECTIVE GRANULOMATA

Syphilis.—Syphilis may affect the gland in one of three ways: An acute parotitis may occur in secondary syphilis. This resembles very closely an ordinary acute inflammation and usually subsides as any of the acute manifestations of secondary syphilis do. The gumma is the most frequent syphilitic process that occurs in the parotid gland, although in itself it is comparatively rare. It grows slowly, usually causing no pain, is not tender and is rather firm to the touch. It is next to impossible to make a diagnosis of this condi-

tion, yet in a patient giving a clear syphilitic history, a course of active anti-syphilitic treatment should be instituted. The gumma may become quite large and eventually break down. It can be differentiated from malignancy in that it does not infiltrate and is attached only to the gland. Later it may become adherent to the skin.

A diffuse syphilitic sclerosis of the gland may occur, much as in the liver. The gland may be but little decreased in size, but is very hard and often the seat of neuralgic pains. The secretions are markedly decreased. This type must be differentiated from the ordinary inflammatory fibrosis. Necessarily the treatment is as for syphilis in general.

Tuberculosis.—Most of the authorities agree that tuberculosis of the parotid gland is a primary infection, the atrium not being definitely known. It may be associated with tuberculosis of the cervical lymph glands or lungs. The onset may be more or less sudden, with a swelling of the gland. At other times it is very insidious, closely resembling the ordinary type of chronic infection. Early the enlargement is quite firm and may be lobulated. At times it rapidly becomes soft and the skin covering it red and edematous. At this time the patient may show distinct tuberculous symptoms, such as afternoon rise in temperature, night sweats, loss in weight and a progressing anemia. Sooner or later the swelling breaks down, discharging the characteristic contents of a cold abscess. In this type of the disease, which may last several months, and where the gland is the seat of considerable infiltration, the tuberculous focus may become encapsulated and the contents cheesy or infiltrated with calcium salts.

The differential diagnosis lies between a neoplasm, the ordinary chronic pus infections and syphilis. Usually the type of individual and the appearance of the swelling, with its more or less characteristic onset, will make the diagnosis probable.

Treatment of Tuberculous Parotitis.—This disease progresses slowly with a deposition of considerable fibrous tissue and usually is associated with fairly good resistance. In these cases forced feeding, hygienic surroundings and tonics have a good effect. Vaccine therapy, cautiously used, is strongly indicated. When the disease does not yield to ordinary treatment and has a tendency to progress, operative procedures must be resorted to. Due to the peculiar structure of the gland, caution must be exercised in its removal. A single abscess may be drained or resected. When the whole gland is more or less involved it is possible at times, by freeing the facial nerve and the vessels, to remove the greater portion of it without the ordinary disastrous results.

Actinomycosis.—This type of infection of the gland is practically always secondary by extension from the maxilla. The onset is very similar to that of tuberculosis, although as a rule the gland breaks down much sooner, discharging the characteristic sulphur granules. The positive diagnosis is made by finding the ray fungus in the pus. This subject is taken up more in detail under Actinomycosis, page 40.

STENSON'S DUCT

Stenson's Duct, or the duct of the parotid gland, is about 6 cm. long and 0.3 cm. in diameter. Superficially the duct is represented by a line drawn from the lower margin of the concha to a point midway between the ala of the nose and the vermilion border of the lip. The duct passes over the masseter muscle and, at its anterior border, turns almost at right angles to penetrate the buccinator muscle. The orifice, which is the narrowest part of the duct, is situated on the summit of a papilla at the level of the second upper molar tooth. It will thus be seen that a certain portion of the duct is readily exposed to external violence.

Injuries.—The most frequent injury to Stenson's duct is a stab or gunshot wound. The duct may be simply severed or a portion of it destroyed, resulting in a fistula. Foreign bodies may enter the duct and cause a traumatization of its lining membrane, the latter possibly leading to a stenosis. Crushing injuries may rupture the duct and yet not cause a break in the skin. This is rare.

Inflammation (Sialoductitis).—Etiology.—The active cause is practically always bacterial. It has been shown by Tait that the oral one-third of the duct has an extensive bacteriological flora, practically the same as that of the mouth, consequently, in inflammatory conditions of the mouth, the process necessarily extends a short way into the duct. This has a definite bearing on fistula formation and on the end results of various operations for the cure of fistula.

Such conditions as calculus, foreign bodies and injury lower the resistance of the parts sufficiently to enable the bacteria present to multiply and, by the resulting inflammatory edema, close the orifice of the duct, which consequently produce changes in the duct and the gland itself.

Symptoms of Inflammation of Stenson's Duct.—In the majority of cases the disease is chronic, with repeated acute exacerbations. The orifice of the duct is placed on an inflammatory crater, the edges swollen and red. The orifice may be closed and, by pressure over the duct, a drop of purulent or sero-purulent material will appear. There may be an excess flow of saliva following this, due to an inflammatory stimulation of the gland. With a complete closure of the duct, as a result either of inflammatory edema or a plug of fibrin, a swelling may appear over the course of the duct. Usually this is noticed during the act of eating. It may disappear suddenly, due to the pressure of the saliva either dislodging the plug or forcing open the orifice of the duct. If the orifice is firmly occluded, the swelling may extend to the gland itself.

During the time of the acute swelling, more or less pain is present. If the condition is not relieved, an abscess may form; if left untreated, may rupture externally.

The diagnosis is usually made easily; the presence of a foreign body or a

calculus must always be taken into consideration, as they may act as an exciting factor to the inflammatory process.

Treatment of Inflammation of Stenson's Duct.—The essential element in the treatment of this condition is the removal of the cause. The stringent antiseptic mouth-washes are very beneficial at times. In cases where the duct has been diseased for a long time, medical treatment is, as a rule, very unsatisfactory. The teeth should be put in good order. The orifice of the duct may be dilated. At times sounding of the duct gives good results, but there is always the danger of forcing infective material farther up. Walther recommends flushing the duct with antiseptic solutions. In severe cases it may be drained by an incision in the mouth.

Stenosis of the Duct.—A complete stenosis of the duct may follow a severe crushing injury or an incised wound while partial stenosis may follow prolonged infection. Usually it is manifested by more or less disturbance in the gland, such as salivary retention with secondary infection.

The treatment consists of passing sounds or creating a new orifice in the mouth if the stenosis is near the oral end. As a rule, plastic operations are unsuccessful. Usually the gland undergoes atrophy if the stenosis is complete and permanent. For further operative treatment, the various methods described under the head of Salivary Fistula may be applied.

FISTULA OF PAROTID GLAND AND STENSON'S DUCT

Parotid Fistula.—A fistula of the parotid gland usually follows an injury, with slight secondary infection, or it may follow an operation. As a rule, fistulæ of the gland proper close spontaneously within two weeks. In some cases they become quite obstinate and last for months. They may occur in any part of the gland and, if communicating with one of the larger radicals of the duct, they have a tendency to persist. The skin opening may be pin-point in size and surrounded by granulations. There is always more or less of a discharge of clear fluid, which is markedly increased during the act of eating. The amount is, by no means, as profuse as in fistula of the duct. These fistulæ may close spontaneously, to re-open in a few days.

Treatment of Fistula.—The parts should be kept clean and protected by a dressing. The tract of the fistula may be cauterized and covered with a snug compress. If the fistula persists, the tract should be dissected out and the skin opening accurately approximated by sutures. The gland should be put at rest by a limited and non-stimulating diet. In those cases which resist the ordinary methods of treatment, a total or partial resection of the gland may be done.

Fistula of Stenson's Duct.—The causes of fistula of Stenson's duct are practically the same as for parotid fistula. As they are much more resistant to ordinary treatment and spontaneous recovery, they form by far the greater percentage of fistulæ: In case of injury, with destruction of a considerable

portion of the duct, the fistula resulting is usually permanent and will demand radical treatment. If the oral end of the duct becomes permanently occluded, as usually follows, especially where the duct lies superficially, because the skin and mucous membrane of the duct become united, the fistula is permanent.

Symptoms and Diagnosis of Fistula of Stenson's Duct.—Fistula of the duct closely resembles fistula of the gland, in fact, when it involves the glandular one-third of the duct, it scarcely can be differentiated. The buccal third is affected most frequently, probably due to its bacterial content. The tract of the fistula is, as a rule, very small, admitting only a very fine probe. The secretion is much more abundant than in gland fistula. At times it is possible to pass a probe into both the glandular and oral portions of the duct and, if the latter part of the duct is not permanently occluded, the probe will enter the mouth. In cases which have existed for some time and which have closed for a period of time and re-opened, there frequently is formed a pocket or a subcutaneous salivary cyst. Following this, more than one cutaneous opening may constitute the fistula. Usually with these there is a considerable amount of scar tissue about the fistular orifice, which rarely closes permanently without operative interference.

The three diagnostic points of duct fistula, in contrast to gland fistula, are:

1. The flow of saliva from the normal buccal orifice is either absent or much less than in gland fistula.
2. A probe can be passed some distance in the duct, which is impossible in gland fistula.
3. The amount of flow from the fistula is much more than in gland fistula.

Treatment of Fistula of Stenson's Duct.—Cases which have existed for a short time and which appear to have a tendency to cure themselves may be aided by rest to the gland and cauterization of the tract. Sounding the duct from the oral orifice has a tendency to keep the lumen of the duct patent and facilitate the flow of saliva through the normal pathway. Too frequent or extensive cauterization must be strongly condemned as it only destroys more of the duct and has a tendency to aggravate the condition.

In the resistant cases where the fistula is permanent the methods of treatment are many, which proves that none are efficient. Numerous operations are suggested and, in many cases, the condition is not only unimproved, but worse than before the operation.

Nicoladoni Operation.—Nicoladoni advised the excision of the scar in the duct and approximation of the end with fine sutures. He has had some success, although it can plainly be seen that cases must be chosen with discretion. This method is made possible by dissecting the masseteric portion of the duct free and separating the buccinator muscle from it. By carrying a curved inicision, anterior to the orifice, through the mucous membrane of the mouth, he forms a tongue-shaped flap attached to the anterior edge of the masseter muscle. The flap is turned over the masseter muscle, thus bringing the

buccal end of the duct nearer to the gland and relieving the tension on its walls.

Von Langenbeck Operation.—Von Langenbeck endeavors to implant the distal end of the duct, at the site of the fistula, directly into the oral cavity, thus constructing a new orifice. Here again the duct must be free in order to relieve the tension, or considerable amount of plastic work done in the mouth to prevent sloughing of the tissues or closure of the oral end of the duct.

Kaufman Operation.—Kaufman, following the idea of Desault, de Roy and Richelot, inserts a rubber tube from the fistula into the mouth, letting it project slightly into the oral cavity. The fistular end of the tube is cut obliquely so as to allow the saliva to flow into it. The skin wound is closed and the tube left in position from eight to ten days. Each day it is gradually withdrawn and clipped until the whole tube is removed. In this way the duct is kept patent.

Deguise Operation.—Following somewhat on the Kaufman principle, Deguise has planned a rather unique operation. The fistula's tract to the cheek surface is removed by two elliptical incisions. At the floor of the tract he passes a needle, threaded either with heavy silk or fine wire, and pierces the mucous membrane of the mouth. The other end of the silk or wire is also threaded into a similar needle and passed about 0.5 cm. from the first. The ends of the threads at the mucous membrane side are tied tightly or, if a wire is used, twisted. The skin wound is closed with sutures. The original suture gradually sloughs out into the oral cavity due to pressure necrosis, thus forming a new duct.

Braun Operation.—This operation is designed for that type of fistula where the oral half or more of the duct is completely occluded or destroyed by scar tissue. A transverse incision is made through the cheek parallel with the duct. This is carried down to the mucous membrane and the latter separated from its underlying structures for some distance. It then becomes possible to draw the lax mucous membrane well over toward the parotid gland. It is now divided parallel to the skin incision and the two edges fastened with running catgut sutures well over on the masseter muscle. The free end of the parotid part of the duct is then passed between the edges of the mucous membrane and sutured, thus making the short duct empty into a funnel formed by the mucous membrane of the cheek. The skin wound is closed by sutures. In order to make this operation successful, the mucous membrane must be well loosened, at the same time preserving the blood supply. Too much tension will cause the stitches to break through and the operation to be a total failure.

Obliteration of the Gland to Cure Fistula.—Owing to the fact that in many cases operative procedures fail, and since the fistula is a constant source of annoyance to the patient, it was conceived by Dupuytren and others to destroy the gland. Many methods were attempted until Viborg suggested ligation of the duct. Bramann did this, but his results were not

satisfactory due to infection with serious consequences at times. Recently Tait made an exhaustive study of the bacteriology of the duct and has shown that, in the presence of infection, ligation is useless. Following ligation in the central one-third, or where the duct is practically bacteria free, there appears a cystic-like tumor with slight tenderness. This disappears gradually and is, undoubtedly, an accumulation of secretions from the glands. Then, following the general rule as to sudden closure of the duct of a gland, it undergoes atrophy and is replaced by fibrous tissue. He has shown further in animals that ligation in the oral one-third of the duct is usually followed by a similar tumor which gradually increases in size, becomes painful, very tender and, if left alone, forms an abscess.

In general it must be said that each case of salivary fistula must be studied carefully and the method of treatment carefully selected.

CALCULUS—SIALOLITHIASIS

Calculi are found more frequently in the duct than in the gland proper and, in comparison with all salivary calculi, about twenty per cent. occur in the parotid gland or Stenson's duct.

Etiology.—Calculi are found more frequently in males than in females. There seems to be no question that calculus formation in the salivary apparatus, as elsewhere, is caused primarily by infection. Salivary calculi are composed essentially of phosphate and carbonate of calcium. When these salts are dissolved by acids, a residue of inorganic material remains, which consists of bacteria and their products. In many instances a distinct bacterial nucleus is found in the stone. Whether the stone found in the duct is formed there, or whether the process begins in the gland originally, is questionable.

In the majority of cases the calculi are small. They may be single or multiple. In the latter case they are practically always small. Since the process is constructed on an inflammatory basis, the dividing line between calcareous degeneration of a chronic inflammation and calculus formation proper is arbitrary. When the stone is found in the duct, it is practically always oblong, often grooved. In this case it is very plausible to conceive a cluster of bacteria or a small foreign body lodging in the duct. Following an inflammatory reaction, salts are deposited upon this framework. As the saliva pours over it, the process continues until the stone becomes of sufficient size to cause a pronounced reaction. The irritation on the duct wall produces an acute inflammatory reaction with the destruction of tissue. Acute swelling causes a more or less complete obstruction with a subsequent disturbance in the gland. An abscess may form behind the stone, which may rupture externally or into the mouth, thus discharging the calculus.

Symptoms.—A stone may lie in the substance of the gland and cause practically no subjective symptoms. At times, due to injury or some un-

known factor, probably a new infection, there is a sudden inflammatory reaction about the stone, the result leading to acute abscess formation with its characteristic symptoms.

With stone in the duct, there appears a rather characteristic symptom complex. During the time of glandular activity, meal time, or at the sight of appetizing food, there will appear a mass at the site of the calculus. This will increase gradually, due to the accumulation of saliva behind the calculus. The acute stasis may be provoked by a swelling of the duct wall, thus obstructing the free flow of saliva around the stone. When the tumor becomes tense, intense lancinating pains may be experienced. When the dilatation of the duct becomes sufficient, the saliva may flow again around the stone, and the tumor or salivary retention cyst disappears.

Fig. 829.—Calculous degeneration of salivary gland. This gland became infected and was drained intra-orally. When the inflammation subsided the gland was removed extra-orally.

With the presence of a duct calculus, there is practically always more or less change in the duct wall. The oral orifice is often puffy and red and may discharge a sero-purulent material. This is known as "pyorrhea salivis." Sooner or later, if the stone is unmolested, permanent change will take place in the gland. The interstitial tissue increases, leading to a sclerosis. The gland is subject to a deep swelling which may terminate in suppuration.

When the presence of the stone is doubtful, the Röntgen photograph will often clear the diagnosis. At times it is possible to palpate the stone with a sound or feel it with one finger in the mouth and one on the cheek.

Treatment.—When the stone lies in the oral part of the duct, it must be approached from the mouth. Even though an abscess may be present, so

long as the skin is not broken an incision should be made from the oral cavity and the stone extracted. When an external fistula is present, it may be enlarged and the calculus removed. If the duct is patent, the fistula often closes spontaneously after removal of the stone. Nothing but cleansing mouth-washes need be used after this procedure.

If the stone is located in the gland or in the duct in close proximity to the gland, an external incision must be made, care being taken not to injure the duct except to open it and remove the stone. It may be possible then to suture the edges and thus prevent a fistula. With a solitary stone in the gland, a small incision can be made and the offender removed. In case of multiple stones, it may become necessary to resect portions of the glands, carefully avoiding the blood-vessels and the facial nerve. It is even possible to remove practically all the gland and yet preserve the nerve (see chapter on Tumors). The latter operation need be done only in exceptional cases.

FOREIGN BODIES

Foreign bodies but rarely ever enter Stenson's duct. The location of the orifice and its narrow caliber afford a protection. Fish bones, brush bristles and small particles of bone may find their way into the duct.

With the entrance and subsequent lodging of such a foreign body, the patient may experience a severe pain. This is usually followed by an edema of the wall of the duct and salivary stasis, producing an intermittent salivary tumor. The gland itself may swell suddenly and, unless the obstruction is relieved, suppuration may result.

The foreign body may lie dormant for a period of time and subsequently form the nucleus for a calculus and only then cause any symptoms. In either case, if untreated, the subsequent symptoms and changes are similar to those encountered in the presence of a calculus.

The treatment is practically the same as for calculus. Often it is possible to allow the foreign body to discharge itself by stretching the orifice of the duct. This is especially applicable in those cases which are recent and are accompanied by a salivary retention tumor. By dilating the orifice, the foreign particle may be flushed out by the saliva, which is released from its pressure. Subsequent use of mouth-washes will be sufficient.

VON MIKULICZ'S DISEASE

Von Mikulicz has recently described a peculiar affection of the salivary glands characterized by a bilateral enlargement with, at times, an enlargement of the lachrymal glands.

The onset is very insidious. The parotids often are the first group of glands involved. There is a gradual symmetrical enlargement of the glands and, in the course of several months, the sublingual, submaxillary and lachry-

mal glands show a similar enlargement. General symptoms are wanting. The patient is usually in a good state of nutrition and most frequently in the prime of life. There are no blood changes.

This condition may progress for months and then become latent, being manifested only by the stationary enlargement of the glands. At times the glands, due to their size, cause secondary symptoms, such as a conjunctivitis and various changes in the mucous membrane of the mouth. These are attributed to impaired function, probably a hypo-secretion. The process is always intracapsular and has never been known to take on the characteristics of malignancy. Microscopically, the gland is the seat of a marked round cell invasion.

The treatment is unsatisfactory. The X-ray has been used with more or less satisfactory results. Such drugs as potassium iodid and arsenic have given temporary relief at times. Surgical interference rarely should be attempted as the disease in itself is not fatal. If the glands become very large, impairing mastication and the necessary functions of the mouth, an effort may be made to remove them.

TUMORS

Tumors of the parotid gland may be divided into three groups: benign, malignant and "mixed tumors." This classification includes only true neoplasms and not inflammatory enlargements or cysts.

Benign Tumors.—Benign tumors of the parotid gland constitute by far the smallest per cent. of parotid tumors. In general, their nature, mode of onset and course are similar to tumors elsewhere.

Angiomata.—Lymphangiomata are very rare, but have been reported. They are soft, fluctuating, easily compressible tumors and usually appear early in life. On examination they show gland tissue lying between the cavernous lymph spaces. Since they involve only a part of the parotid gland, as a rule, it is often possible to remove them without injury to the important structures. Hemangiomata are more frequent than lymphangiomata. They are often congenital and then resemble the ordinary nevus. They contain a considerable amount of erectile tissue, consequently change their size quite readily. Frequently the tumor consists of a simple varix only. In the early cases when the growth is small it may be removed by carbon dioxide snow. When more advanced, its removal is indicated surgically.

Lipomata.—True lipomata of the parotid must develop from the interlobular fat and must be differentiated from a simple subcapsular tumor. This tumor is found most frequently in women and is a semi-fluctuating mass growing rather slowly and causing no pain. Often they are lobulated. Lipomata cause no symptoms, as a rule, until they become large when the pressure leads to atrophy of the gland. The patient usually seeks relief simply from the unsightly appearance.

In the simple encapsulated lipoma, surgical removal is easy. When deep-seated, this is often extremely difficult, as it requires the resection of a large portion of the gland. The facial nerve and artery should be dissected out and protected.

Neuromata.—Cases of tumors of the facial nerve located in the parotid gland are reported, although they are very rare. A parotid neuromata usually is small and causes considerable pain, these being the diagnostic points. Surgical removal is the only treatment and this necessitates the section of the facial nerve with the resulting facial paralysis.

Fig. 830.—Inoperable carcinoma of the salivary glands on both sides in a boy eleven years old. There was an extensive metastasis in the lymphatics.

Myxomata.—Pure myxomata of the parotid are rare as practically all fall under the group of the so-called "Mixed Tumors." Volkman points out that different stages in myxomatous degeneration give the different types of mixed tumors.

Fibromata.—Practically all the cases of fibromata also fall in the class of mixed tumors, since they rarely consist entirely of fibrous tissue, but are truly mixed tumors. A few cases are reported, showing a hard, firm growth which cuts with resistance, the cut surface being reddish-white in color and often glistening. They cannot be differentiated clinically from mixed tumors.

Adenomata.—It was long disputed that adenomata of the parotid gland occurred. Volkman classed them with mixed tumors. Cases of pure ade-

nomata have been reported, Nasse probably being the first to demonstrate them. They are slowly growing encapsulated tumors, rather soft, the contents being easily expressed. They show an especial tendency to undergo malignancy. Clinically, these tumors cannot be differentiated from mixed tumors.

Treatment of Benign Tumors of the Parotid—Those benign tumors, which are clearly encapsulated, can be enucleated with complete recovery.

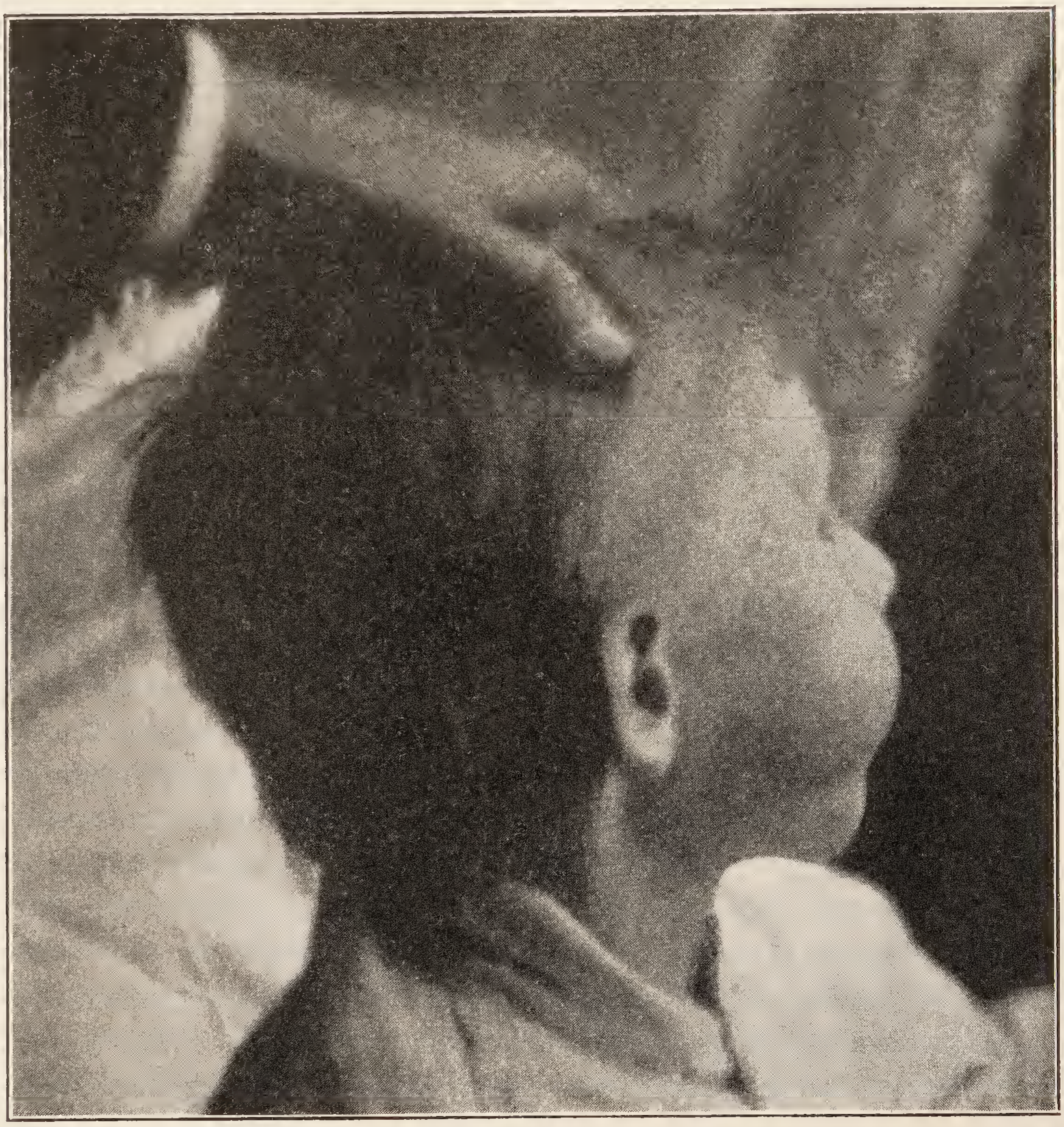


FIG. 831.—Side view of the same boy.

At times it is impossible to do this without destroying the nerve and the resultant facial paralysis is more disagreeable than the presence of the tumor. Some are not clearly encapsulated and seem to invade the entire gland more or less. In these cases it is possible to resect the entire gland, preserving the continuity of the nerve and thus avoid facial paralysis. Care should be exercised to remove the growth *in toto*, as many fall in the class of mixed tumors. It is not an infrequent occurrence to have malignancy follow if a small portion remains. This has been one objection in trying to preserve the seventh nerve.

Malignant Tumors.—Sarcomata of the parotid gland are comparatively rare. They may be divided into fibro-sarcomata, round-cell sarcomata, spindle-cell sarcomata and melano-sarcomata. The fibro-sarcomata are comparatively benign and somewhat resemble the fibroma in structure and growth. The tumor is a hard, slowly growing one and cuts with considerable resistance, the cut surface resembling that of the fibroma. Portions may undergo cystic degeneration and, in this instance, the tumor resembles a mixed tumor. The spindle-cell sarcomata fall next in order as to malignancy. They are often fairly well localized and may appear to have a capsule. This type grows more rapidly than the fibro-sarcomata and is not so hard. The round-cell sarcomata are diffuse, rapidly growing tumors, rather soft to the touch and exceedingly malignant at times. Metastasis occurs very early. The melano-sarcomata are the most malignant of parotid tumors. They are characterized by exceedingly rapid growth and by the deposition of a large amount of pigment. Pigmented metastatic tumors occur very early and the disease is soon fatal.

Carcinomata.—The differentiation between carcinomata and mixed tumors is very difficult at times since the mixed tumors are endothelial growths to a considerable extent and take on an appearance very similar to carcinomata.

Carcinoma is more frequent than sarcoma of the parotid gland. It may be primary or secondary from a carcinoma of the mouth or adjacent parts. Todd reports six per cent. of salivary tumors as carcinoma. Koeidg has pointed out that practically all parotid cancers are of the encephalost character, containing a large amount of epithelial tissue and but little stroma. They are usually very malignant. The fibrous or scirrhous carcinoma usually occurs late in life. The tumor is slower in growth, small and associated with retraction and contraction of the parts. It resembles a scirrhous carcinoma of the breast. One type of scirrhous carcinoma causes a marked retraction of the parts while the other affects the skin, resembling the "cancer en cuirasse" of the breast. The scirrhous type often leads to an early facial palsy or paralysis due to contraction and subsequent destruction of the seventh nerve. Metastases occur late in contrast to the nebulary type. The nebulary type of carcinoma may appear early in life, usually grows quite rapidly and forms a large tumor. This type often breaks down early to form a fungating sloughing tumor, which is very susceptible to severe hemorrhages.

Early carcinoma of the parotid gland presents few symptoms. Slight tenderness on pressure may be the first symptom. As the disease progresses, pain is located in the temporo-mandibular articulation. In reality this is due to the movement of the muscles in the act of mastication. The gland soon swells and may attain an enormous size. With the increase in the size limitation of the mobility of the mandible increases.

Pain is a constant symptom in cancer of the parotid gland and is more marked in the scirrhous type when it is frequently referred to the face.

In making a clinical diagnosis of carcinoma of the parotid, we must not overlook the chronic inflammatory processes, also tuberculosis and syphilis. As in diseases of the breast, the chronic inflammations very closely resemble cancer, and it is not at all infrequent to find a chronic inflammation undergoing a malignant degeneration. With a more or less subacute exacerbation of a chronic parotitis, the lymph glands may become enlarged and the mass adherent to the surrounding parts and skin.

It is practically impossible to differentiate clinically carcinomata from mixed tumors, except when the growth takes on the pronounced signs of an encephaloid cancer.

Mixed Tumors.—About sixty per cent. (Todd) of parotid tumors are classed as mixed tumors. This type of tumor has been a topic of dispute for a long time as to whether it is a mixed connective tissue growth, a modified epithelial tumor or an endothelial neoplasm.

Hanseman classifies them as:

1. Endothelial carcinoma.
2. Endothelial sarcoma.
3. Endothelial carcino-sarcoma.
4. Endothelial tumors with development of special tissues.
5. Endothelial adenoma.

Volkman confirms the endothelial cell theory and believes that the cartilaginous appearing tissue is derived from a myxomatous degeneration of tissues.

Etiology.—Most of these tumors occur between the ages of twenty and forty, the male being probably twice as frequently affected as the female. Further, nothing can be said as to the causation.

Pathology.—Mixed tumors grow rather slowly; on an average eight years elapse before they obtain any marked size. They are hard, irregular and, as a rule, surrounded by a dense capsule. They often have an uneven consistency, some parts being very hard while others are soft, resembling a cyst. Mixed tumors are not adherent to the skin and, at times, appear distinctly separate from the gland itself, but lie beneath the parotid fascia. They never produce metastasis. These tumors may lie dormant for years or enlarge but slightly, then suddenly, without any apparent cause, become malignant and destroy life within a few months.

On cut section they display a rather interesting picture. Certain parts cut with a cartilage-like resistance. Judd reports that one-fourth of these tumors contain cartilage, while Todd emphatically states that they never contain cartilage, the peculiar stroma of the tumor being mistaken for cartilage. Portions of the cut section give a semi-translucent appearance with sago-grain-like bodies. Cystic degeneration is found frequently.

Microscopically, the cells have a peculiar arrangement, appearing in strands. They remain attached to their membrane when fixed, thus differing from the carcinoma. The cartilage, which, according to Volkman, is derived from the connective tissue stroma having undergone a myxomatous change, is

considered by Todd not cartilage, but simple stroma. He states it has a different structure and staining quality, being slaty in color and homogeneous to granular. Wood says that seventy-five per cent. of these tumors become malignant and that thirty per cent. recur after operation.

Symptoms.—As a rule, this type of tumor, like the benign tumor, gives practically no subjective symptoms. In case it involves a nerve trunk, pain may be present and may radiate to the face, neck or jaws. Later, when the tumor reaches a considerable size, there may be a marked increase in the secretion from the gland, impairment of the motion of the jaw and a decrease in the acuteness of hearing. The tumor, as a rule, is single, well defined and sharply demarcated from the surrounding tissues. To the touch, it often has an uneven consistency, with very hard and soft semi-fluctuating areas. Depending on the portion of the gland involved, the external markings and subsequent appearance will vary. When arising from the upper pole, the tumor obstructs the ear, pushing the auricle outward and backward. When the lower pole is involved, the tumor often extends down the neck into the submaxillary region or under the sterno-cleido-mastoid muscle, pushing the latter backward. Again the tumor may grow inward toward the pharynx.

As has been previously stated, the mixed tumor may grow very slowly for a number of years and then suddenly, without any apparent cause, become malignant, spread very rapidly, produce metastasis and cause death within a few months. This may be provoked by incomplete surgical interference, injury, or it may be entirely spontaneous. Some authorities assert that in the spontaneous cases the tumor has broken through its capsule. When malignancy intervenes, the tumor begins to enlarge rapidly, becomes tender to the touch and the subjective symptoms increase. The adjacent lymph glands enlarge, the tumor softens and may soon break down and ulcerate.

Diagnosis.—The slow growth, hard, well-defined tumor mass, which, as a rule, is uneven and nodular, and its free movability are the characteristic signs of a mixed tumor. The absolute diagnosis must be made by the microscope. .

This type of tumor must be differentiated from ordinary benign tumors, sarcoma, which grows much more rapidly, and from carcinoma. Often it is difficult to differentiate a scirrhous carcinoma from a mixed tumor. The retraction of the parts and its fixation speak strongly for a scirrhous cancer. The medullary carcinoma grows rapidly and, as a rule, breaks down early. It is the seat of considerable pain and usually within three to five months the adjacent lymph glands become enlarged. The tumor becomes adherent to the skin and the surrounding tissues.

The chronic infections, especially the calcareous and fibrous types, tuberculosis and syphilis must be considered when making a diagnosis of mixed tumor. The history of the case, especially as to the onset of the condition,

FIG. 832.

FIG. 833.

will often aid. At times it is impossible to differentiate the chronic infections from a mixed tumor; the microscope must be relied upon then.

Treatment of Carcinoma of the Parotid Gland.—The patient usually seeks relief from a disfigurement and a malady which is steadily, although slowly, growing worse. The only hope for a cure is the total extirpation of the entire parotid gland. It is not an infrequent occurrence to find malignancy follow an incomplete operation. In the encapsulated variety, care should be exercised to remove all of the capsule as well as the tumor. It is possible, when the nerve is not directly involved in the tumor itself, to free it from the cap-

Fig. 834.

sule and preserve its continuity. The author has completely removed the entire parotid gland for carcinoma and preserved the continuity of the seventh nerve. No recurrences of the tumor have occurred to date, although not sufficient time has elapsed to prognosticate a cure (Figs. 832 to 836) When the nerve is involved directly, it then becomes a question whether one may risk the possibility of a recurrence of the tumor with a liability to malignancy or sever the nerve with the resultant facial paralysis.

Operation for Removal of the Parotid Gland.—The removal of the parotid gland may be accomplished with little disfigurement to the patient, provided the disease does not call for the removal of the ramus of the mandible and a portion of the body of the bone. Too frequently, however, the mandible is involved. The incision is made posterior to the ramus of the mandible,

but not high enough to divide the seventh nerve. It is carried down over the external carotid artery which is ligated when exposed. An incision is then carried forward one-half inch below the lower border of the mandible and one and one-half inches long. Blunt instruments are used to dissect the tissues, using great care over the region of the seventh nerve. It should be preserved intact and uninjured. After the artery is ligated the tissues are reflected upward so as to expose the gland, which is then carefully enu-

FIG. 835.

FIGS. 832–835.—Carcinoma of the left partoid gland in a woman forty years old. Fig. 832, view of inside of the mouth. Fig. 833, posterior view showing the distention of the cheek. Fig. 834, front view showing the facial deformity. Fig. 835, patient after operation. The entire gland was removed. The nerve was dissected without injury, thus avoiding facial paralysis. The figure shows perfect motion of all the muscles.

cleated. The duct is disregarded. After the removal of the gland, the muscular tissue is approximated with catgut, while the fascia and skin are closed with horse-hair sutures. A drainage tube is inserted in the most dependent part of the wound. A compress and light bandage are applied until the parts have healed.

SUBMAXILLARY AND SUBLINGUAL GLANDS

Due to the close association, these two sets of glands will be considered conjointly. The submaxillary gland lies beneath the cervical fascia under the ramus of the mandible, a little anterior to the angle. By pressing upwards from the outside, the gland may be felt in the floor of the mouth to the side of the frâenum of the tongue. It is lobulated and enclosed in a capsule.

Formerly it was thought that there were lymphatic glands within its substance, but at the present time it is conceded that this is not true. A few lymph glands are found embedded in the capsule. Wharton's duct, the duct of the submaxillary gland, is about two inches long and extends from the substance of the gland forward beneath the mylohyoid muscle along the floor of the mouth external to the sublingual gland and opens on a summit beside the frâenum of the tongue. Its orifice is its narrowest part.

The sublingual gland is an elongated, almond-shape body lying in the floor of the mouth just beneath the plica sublingualis. It is covered only by the mucous membrane and lies on the mylohyoid muscle, internal to the

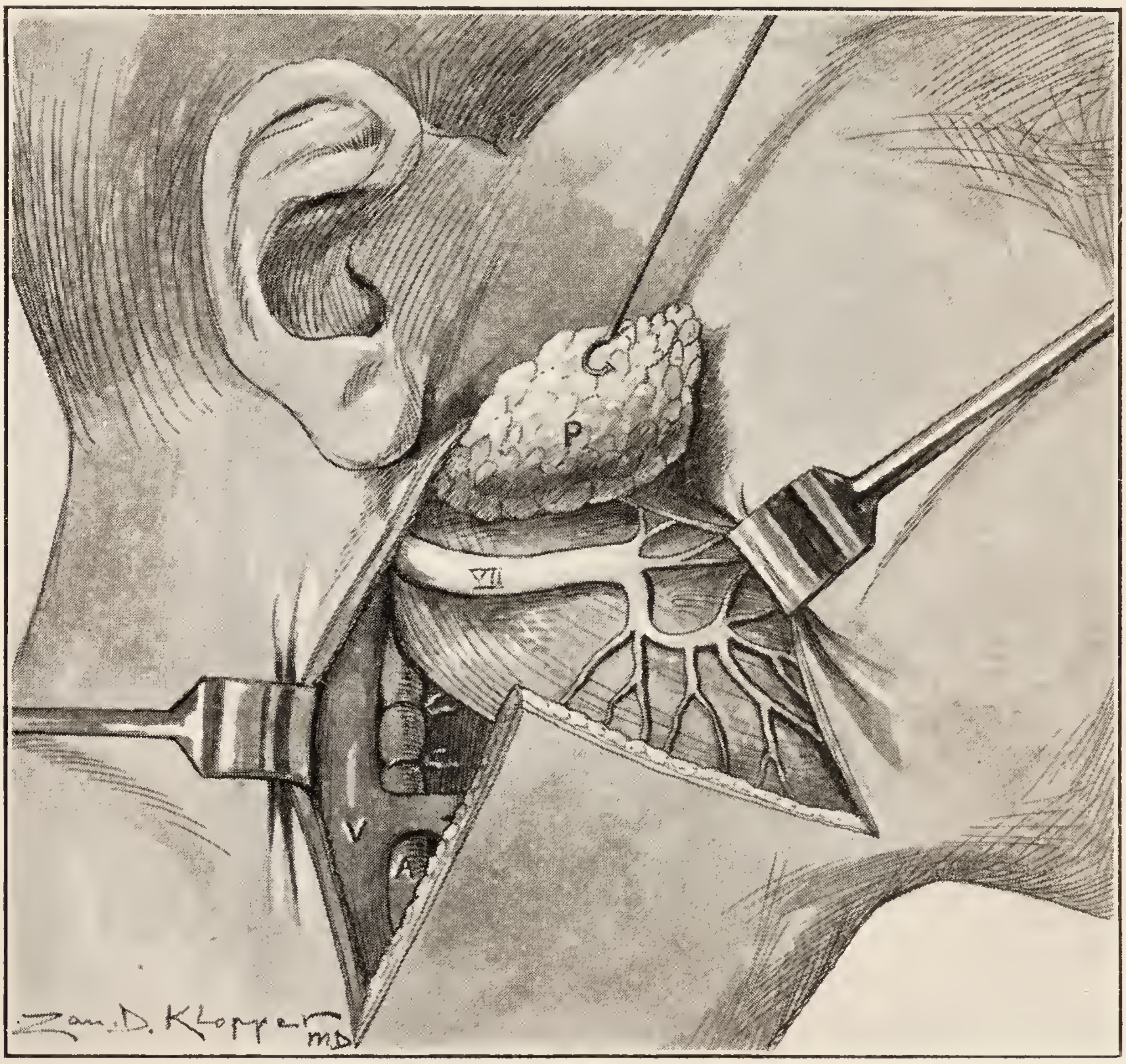


FIG. 836.—The seventh nerve dissected out during operation for the removal of the parotid gland. The nerve function was preserved and paralysis avoided.

mandible and external to the genio-glossus muscle. It is about 40 mm. in length and consists of many lobules closely held together by a few strands of connective tissue. In itself it has no capsule. In the embryo it consists of many separate glands. The ducts, known as the ducts of Rivinus, are numerous, emptying on the summit of the plica sublingualis.

Injuries to the Glands.—Due to the protection afforded them by their position, the submaxillary and sublingual glands are seldom injured. A direct blow to the jaw may injure the submaxillary gland. Gun-shot and stab wounds of the glands may be encountered. Foreign bodies in the mouth

may penetrate the sublingual gland. The treatment consists essentially of cleanliness of the mouth, and is similar to that applied in acute injuries of the parotid gland.

Acute Inflammation.—The most common form of acute infections in these glands is by way of the ducts from the mouth. Such conditions as acute stomatitis, caries of the teeth, infected tonsils and adenoids or an old discharging sinus may lead to an acute infection of the gland. Stenoses of the ducts or calculus, especially in Wharton's duct, may predispose. During the course of any acute infectious disease, we may encounter an inflammation of one of these glands.. The process may resolve or go on to suppuration.

Symptoms.—The symptoms of acute infection of these glands is very similar to that of the parotid. Usually the onset is sudden. The gland enlarges, becomes very tender and, as the intra-capsular tension increases, the patient will suffer considerable pain. The process may subside and resolve or may continue to suppuration, breaking through the capsules and descending the neck under the fascia, even as far as the mediastinum. The process may point externally and rupture spontaneously. This condition is very closely allied to the streptococcic cellulitis known as Ludwig's Angina and may be a forerunner of that fatal malady.

An acute distention of the submaxillary gland may occur from an occlusion of Wharton's duct, the latter being due either to a calculus, a foreign body or an acute swelling. The gland increases in size rapidly, is tender to the touch and has a peculiar doughy consistency. If not relieved, the gland usually becomes the seat of acute inflammation. Astringent mouth washes, such as liquor alumini subacetatis dilute, may relieve the condition. If not, a small, smooth probe should be passed into the orifice of the duct.

The treatment is essentially that discussed under acute infections of the parotid. It may be added that, if ordinary palliative treatment does not affect the disease within a short time, drainage should be established to prevent the disease spreading, which may lead to such critical conditions as edema of the glottis or a septicemia. In case a calculus of the duct is present, it should be removed as the duct occlusion may lead to submaxillary fistula.

Chronic Inflammation.—Since the symptoms, pathology and treatment of the chronic inflammations of this group of glands are practically the same as that of the parotid gland, they will not be discussed here, but the reader is referred to the text on parotid surgery.

CALCULUS

By consulting the statistics of Czygan, we find that sixty-one per cent. of the salivary calculi are found in Wharton's duct or the submaxillary gland and eighteen per cent. in the sublingual gland or its ducts.

The symptoms and subsequent changes are so similar to calculus of the parotid and its duct that it will not be considered in detail here. The ob-

jective symptoms in the former are referable to the submaxillary region and the floor of the mouth. Such symptoms and pathology as may occur with an obstruction of the ducts with calculi was discussed in the chapter on Ranula.

The treatment is essentially the same as for calculus of the parotid and Stenson's duct.

TUMORS

See tumors of the parotid.

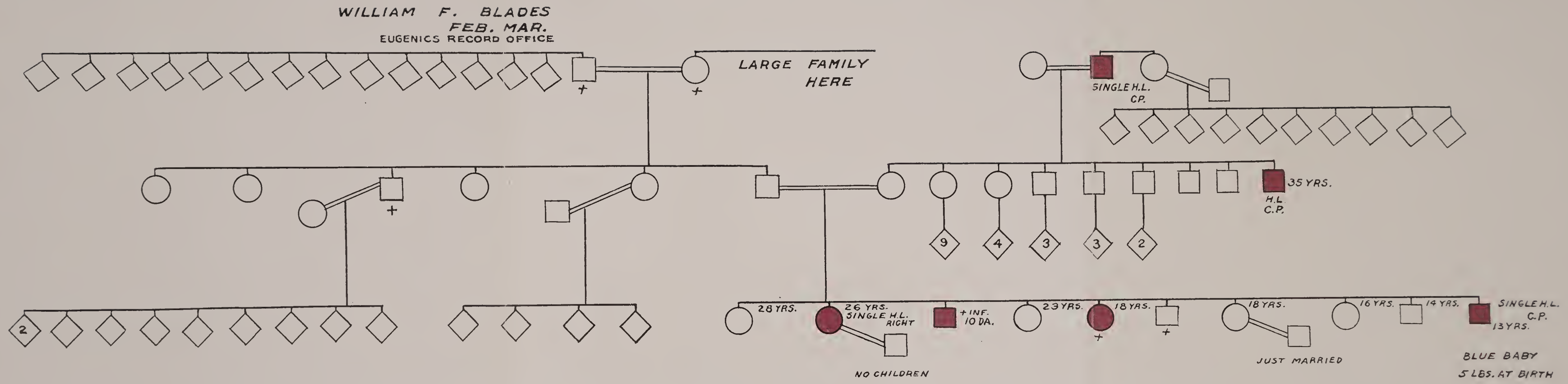


FIG. 837.—Chart of E. S. family showing (in red) the distribution of harelip and cleft palate. □ = male. ○ = female. ◊ = sex unknown. □═○ = parents. (offspring symbol) = offspring.

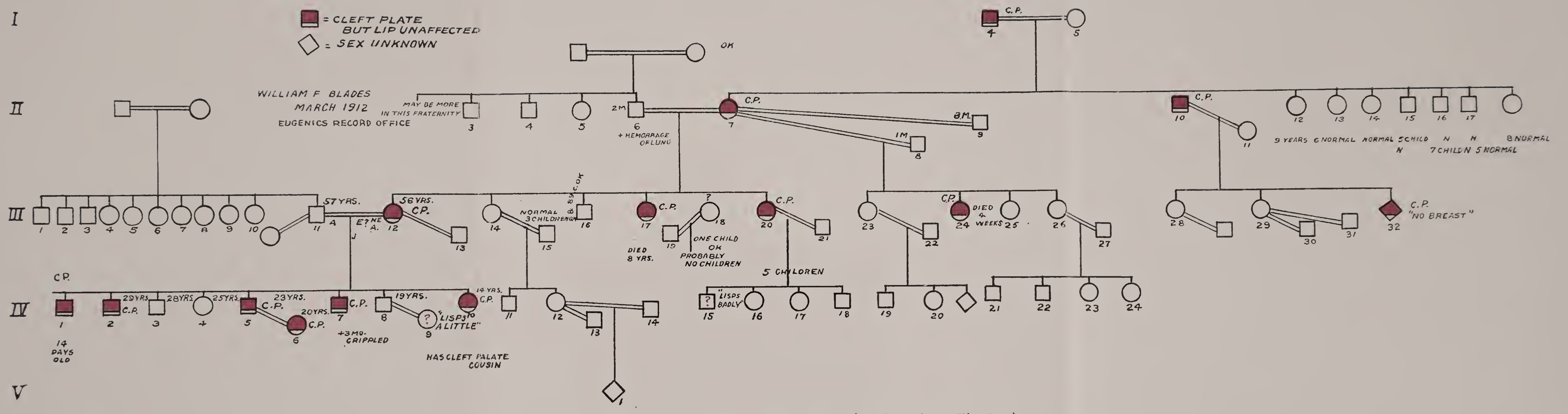


FIG. 838.—P. N. H. family. Cleft palate. (For legend, see Fig. 837.)

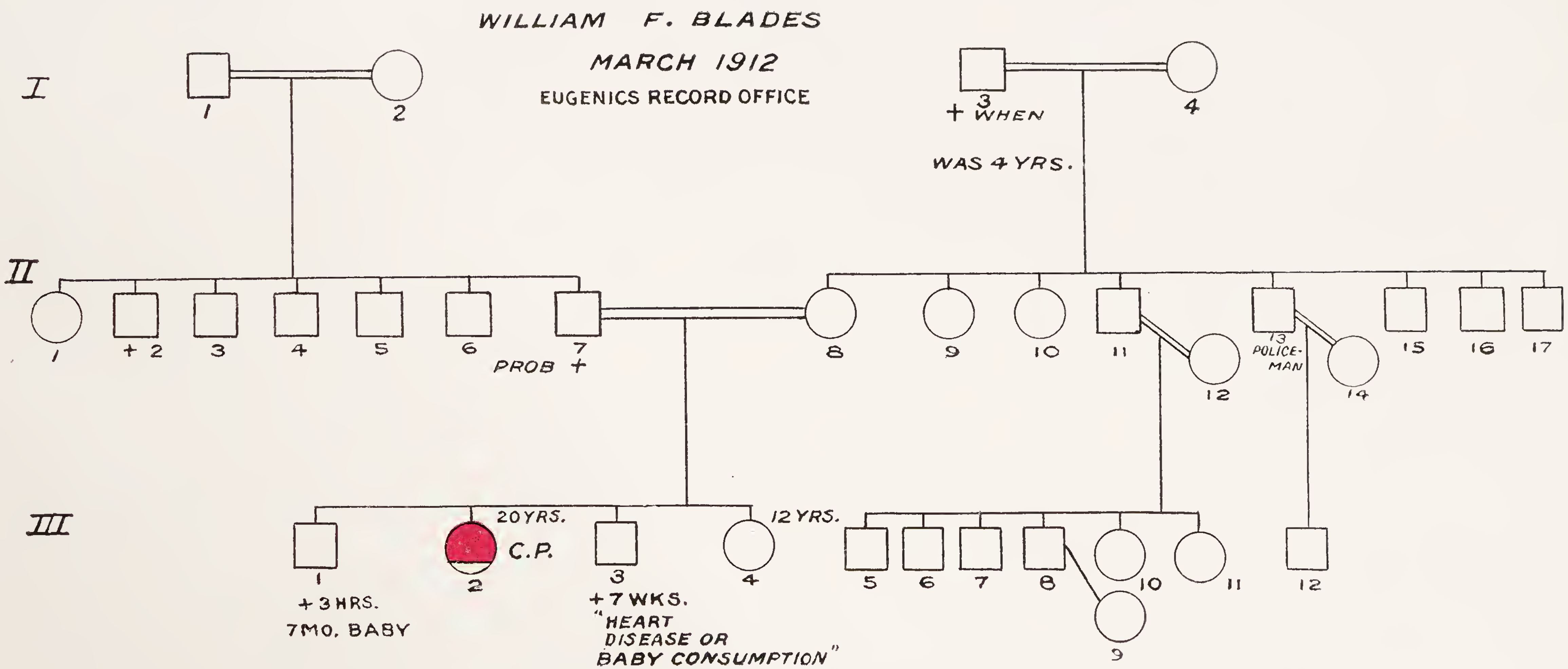


FIG. 839.—A. M. family. (See legend to Fig. 837.)

CHAPTER XXXIX

EUGENICS

During the past decade the subject of eugenics has been receiving more attention from scientific men than in any other period of time. Through the medium of the Eugenics Record Office, Cold Spring Harbor, Long Island, every phase of the subject is under investigation and careful reports of their findings are published from time to time. Through the personal work of Mr. William F. Blades of the Association, I have gathered much valuable information and have given to him the pedigrees of many families with congenital defects.

It has been my habit, when a child is brought to me suffering from a congenital deformity, to look into the family history carefully. The first question asked is "Is this the only child?" If there are others "Are any of them similarly afflicted?" "Has the defect existed in any of the grandparents or among their brothers and sisters?" "Have any cousins or other relatives had harelip and cleft palate?" From the information acquired, the question of heredity of parents, grandparents and other near relatives may be settled.

It is not possible in this book to record all the results of my findings. A few are published here, which point out the prevalence of inherited conditions. The general opinions expressed regarding heredity have been conjectural largely. The work of the Eugenics Record Office must impress even the layman's mind with the unquestionable influence which a congenitally defective parent exerts upon his child. Elsewhere in this book I have expressed my belief that heredity is a powerful influence in causing cleft palate and harelip. The systematic work, scientifically conducted by the Eugenics Record Office, their facilities for tracing pedigrees and recording statistics will be of inestimable value in the study of congenital deformities.

What is Eugenics?—To understand what is to follow, it is necessary that we have a knowledge of what eugenics is. In a valuable treatise by Charles Benedict Davenport, entitled "Heredity in Relation to Eugenics," we find the following: "Eugenics is the science of the improvement of the human race by better breeding, or, as the late Sir Francis Galton expressed it, 'The science which deals with all influences that improve the inborn qualities of a race.' The eugenical standpoint is that of the agriculturist who, while recognizing the value of culture, believes that permanent advance is to be made only by securing the best 'blood.' Man is an organism, an animal,

and the laws of improvement of corn and of race-horses hold true for him also. Unless people accept this simple truth and let it influence marriage selection, human progress will cease. Eugenics has reference to offspring. The success of marriage, from the standpoint of eugenics, is measured by the number of disease-resistant, cultivable offspring that come from it. Happiness or unhappiness of the parents—the principal theme of many novels and the proceedings of the divorce courts—has little eugenic significance, for eugenics has to do with traits that are in the blood, the protoplasm."

Among the statistics I have gathered in my own practice, I publish the following few cases:

Fig. 837 represents the family tree of patient M. E. on whom I operated in 1886 when she was ten days old. This patient had a double harelip the premaxillary bones protruded and there was a wide cleft of both hard and soft palates. I was able to follow the history of this patient until her death, at the age of twenty-one. This girl grew to be a very attractive young lady, with perfect speech and with unusual skill in vocal music. In this family there were ten children. The first, a girl, was normal. The second, a girl, had single harelip, which I operated. The third, a boy, had a double harelip and cleft palate. He died without an operation when he was ten days old. The fourth was a girl, normal, and the fifth had a double harelip and cleft palate. I also operated upon her. The sixth was a boy, the seventh a girl, the eighth a girl, the ninth a boy, all normal. The tenth, a boy, had a single harelip and cleft palate. This boy was operated upon by me when he was three months old. The parents of these children were normal, but a brother of the mother had a cleft palate and harelip. The mother's father was also affected with a harelip and cleft palate.

Mr. Blades, who investigated this family, furnished me with the following report: "Examined the palate of the father of these children and found it well rounded and, possibly, slightly high. The mother's palate is much higher than her husband's, but there is no defect. The ninth child has a palate higher than its mother's. The arch extends up to an unusual height. The tenth child has a high palate, the cleft and harelip have been closed." The other children were not examined by Mr. Blades. The mother told him that her youngest brother and her father had cleft palate and harelip. She attributed the condition of her defective children to inheritance from their grandfather. She stated that she had never permitted her mind to dwell much on such possibilities during pregnancy and knew of no maternal impression of any kind. She had always eaten well and had never lived upon any peculiar diet. Her taste in food was normal and like that of the average individual. She suggested that, in the second month of pregnancy for the first child affected, her father dropped dead suddenly. The parents stated that all the affected children had bad, easily decayed teeth. They were slow in development. The fifth child (the one described above) weighed four pounds at birth. The tenth child was a blue baby and weighed five pounds at birth. The mother said that all the affected children were smaller when they were

born than those not affected. These children were all unusually attractive physically.

The parents were born in northern Germany and lived only a few miles apart. They never heard of any blood relationship between them. The history on the father's side is very meager, yet he declared that cleft palate and harelip were unknown in his family. The father is a sturdy, healthy man, a brick mason by trade. The mother is also in excellent physical condition.

In 1905 I was invited to give a surgical clinic at a meeting of the Northern Indiana Dental Society at Logansport. Arriving at the hospital, I found two patients suffering from cleft palate. The mother, Mrs. P., who also had a cleft palate, was with them. Upon inquiry, the most remarkable family history, so far as this deformity is concerned, was revealed. The question of heredity cannot be settled by a single family history. The deformity occurring so frequently among the descendents of the grandfather of the child upon whom I operated would, I think, convince the most skeptical that the influence of heredity is most impressive. The pedigree herewith appended (Fig. 838) gives the details. It will be seen that the grandfather of the child had a cleft palate. He had a son and a daughter, among nine children, who were similarly defective. The son had three children, one of whom had a cleft palate. The daughter married a man whose family, so far as history records, was free from the defect. Three of her six children had cleft palates. After the death of her first husband, she married again and bore four children, one of whom had a cleft palate. The history of her second husband was good, so far as obtainable. Thus, of her ten children, four had cleft palates. The oldest daughter, who had a cleft palate, married a man who had ten normal brothers and sisters. The father and mother of these children were normal. The results of this union were eight children—six boys and two girls. The oldest girl was the fourth child and the youngest was the eighth. The first, second, fifth and sixth sons and the second daughter had cleft palates.

It is interesting to note, in the third division, that the fifth son, who had a cleft palate, married a woman who, also, had a cleft palate. So far as history records, the woman's family was free from the defect. The sixth son married a woman who lisped and was supposed to have a cleft palate. A cousin of this woman had a cleft palate.

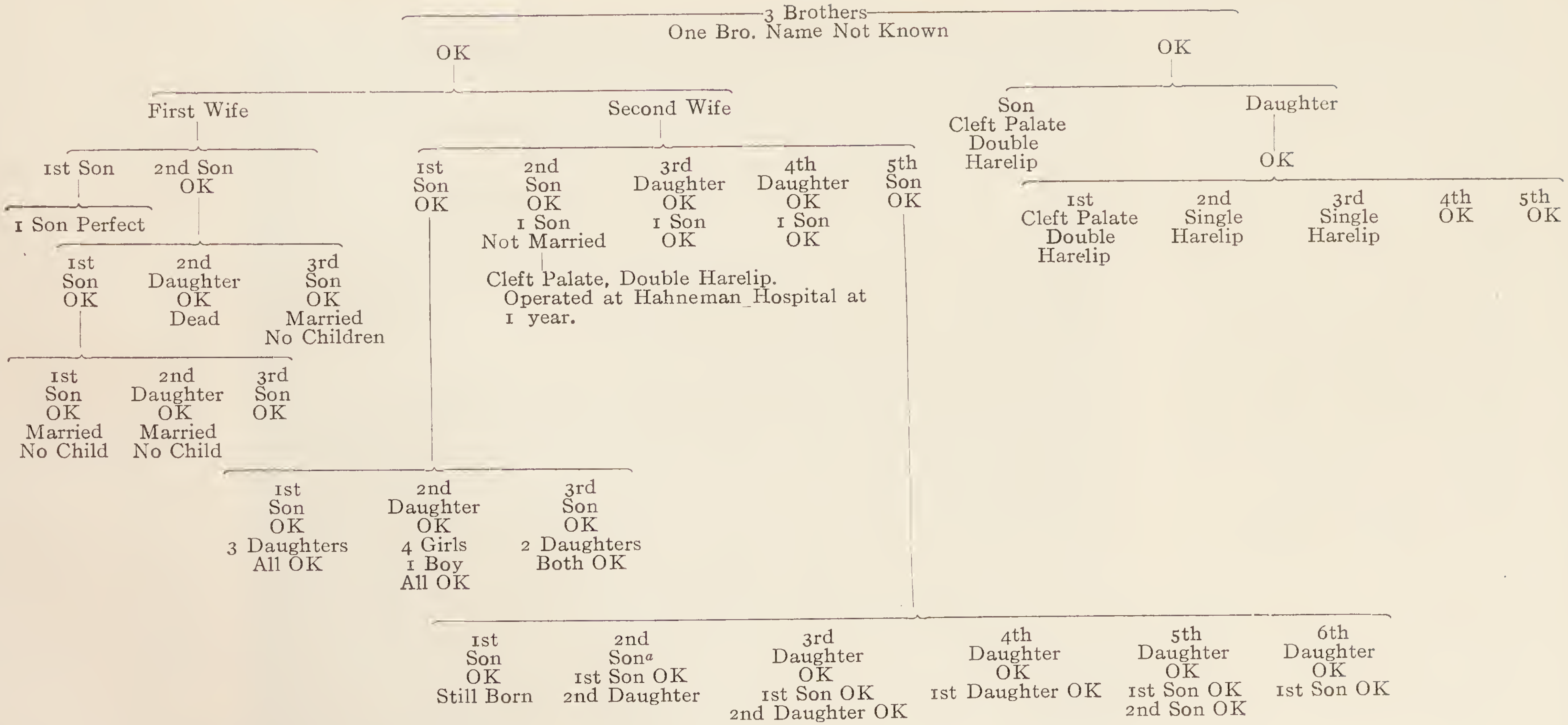
In tracing a pedigree, we gather information only so far as history or tradition records; beyond this we know nothing. When congenital defects occur with frequency in different branches of a family, in my opinion there is no doubt that such defects have existed in progenitors; if not immediate, in those remote. In evidence of the foregoing, I submit the pedigree in Fig. 839.

It will be noticed that, in a family of three brothers, the first was married twice. In the three generations of the descendents of his first wife, nine members, there was no defect. Of the descendents of the second wife there

were five, three sons and two daughters. The second son, normal, was the father of a child with congenital double harelip and cleft palate. Of the six children born to the fifth son, the second one was the father of a child with double harelip and cleft palate. Another brother of the progenitor first referred to had one son and one daughter. The son had a cleft palate and double harelip. The daughter was normal. She had five children; the first had a cleft palate and double harelip, the second had a single harelip and the third had a single harelip. The fourth and fifth were normal.

"Admitting, as we must, the importance of hereditary tendencies in determining man's physical traits, his behavior and his diseases, we cannot overlook the question that must occur to all—What relation has the fact of heredity to those of environmental influence, to the known facts of infection and bad conditions of life? Indeed, were we to accept the teachings of some, environment alone is important; good training, exercise, food and sunlight can put anybody in a 'normal' condition.

"So long as we regard heredity and environment as opposed, so long will we experience endless contradictions in interpreting any trait, behavior or disease. The truth seems to be that, for human phenomena, there is not only the external or environmental cause, but also an internal or personal cause. The result is, in most cases, the reaction of a specific sort of protoplasm to a specific stimulus. For example, the controversy as to the inheritableness versus the communicableness of 'the itch' receives a simple solution if we recognize that there is an external agent, probably a parasite, that can, however, develop only in persons who are non-immune. Since such persons are rather uncommon and the absence of immunity is inheritable, the disease tends to run in families and can rarely be caught, even through inoculation, by persons outside such families. Even in cases where the hereditary factor is universally admitted, as in depressive insanity, the onset of the symptoms, may be delayed by very favorable conditions of life. However, though such symptoms may be diminished and the patient discharged from the hospital as 'cured,' yet the weakness in his germ plasm is not removed and will, unless he is fitly mated, show itself in his children when they, in turn, experience an unusual stress. The fungue tendency of the child of three years might not have expressed itself so acutely had he lived in the country, with freedom to wander widely at will, instead of being restrained within the confines of city houses and narrow streets. In extreme cases, however, of which complete albinism is an example, the trait seems to be due to the entire absence in both of the united germ cells of any determiner for the character. Under these circumstances, not even the best of environmental conditions can bring about pigmentation. Albinism is a protoplasmic 'accident,' as independent of environment as drowning by the overturning of an ocean steamship is independent of heredity. With few exceptions, the principle that the biological and pathological history of a child is determined both by the nature



a H. C. K. had Cleft Palate, Double Harelip.
Operated at 1 year. By Dr. McLean at Ann Arbor, Mich.
Operated at 7th year at Hahneman Hospital, Chicago.
Operated at 35th year. By Dr. T. W. Brophy at Los Angeles, Cal.
Dr. King's father and mother both healthy and rugged.
The mother does not remember any fright, hurt or strain while carrying child.
The mother had two front teeth filled before she knew she was pregnant.

of the environment and the nature of the protoplasm may be applied generally."[1]

The above facts seem to strongly indicate the influence of environment as a factor in the etiology of congenital defects. Experience, based upon many years of observation, first led me to wonder why so many patients suffering from congenital cleft palate and harelip came from the same community. In view of the conclusions reached by students of eugenics, I am satisfied that these defects are endemic. The town of Bay City, Michigan, furnishes the most striking example of the truthfulness of the above conclusions. I am informed by Professor Lyons of Ann Arbor that thirty-two people in this town of 45,166 inhabitants were found to have congenital cleft palate and harelip. In the town of Blue Island, Illinois, nine patients were brought to me within three years.

[1] Davenport book on Heredity.

CHAPTER XL

PROSTHESIS

INTRODUCTION

Value of Prosthesis.—Aside from the great work of orthodontia, which contributes so much to the improvement of facial expression, prosthesis, in restoring parts congenitally absent or lost by trauma or disease, calls for

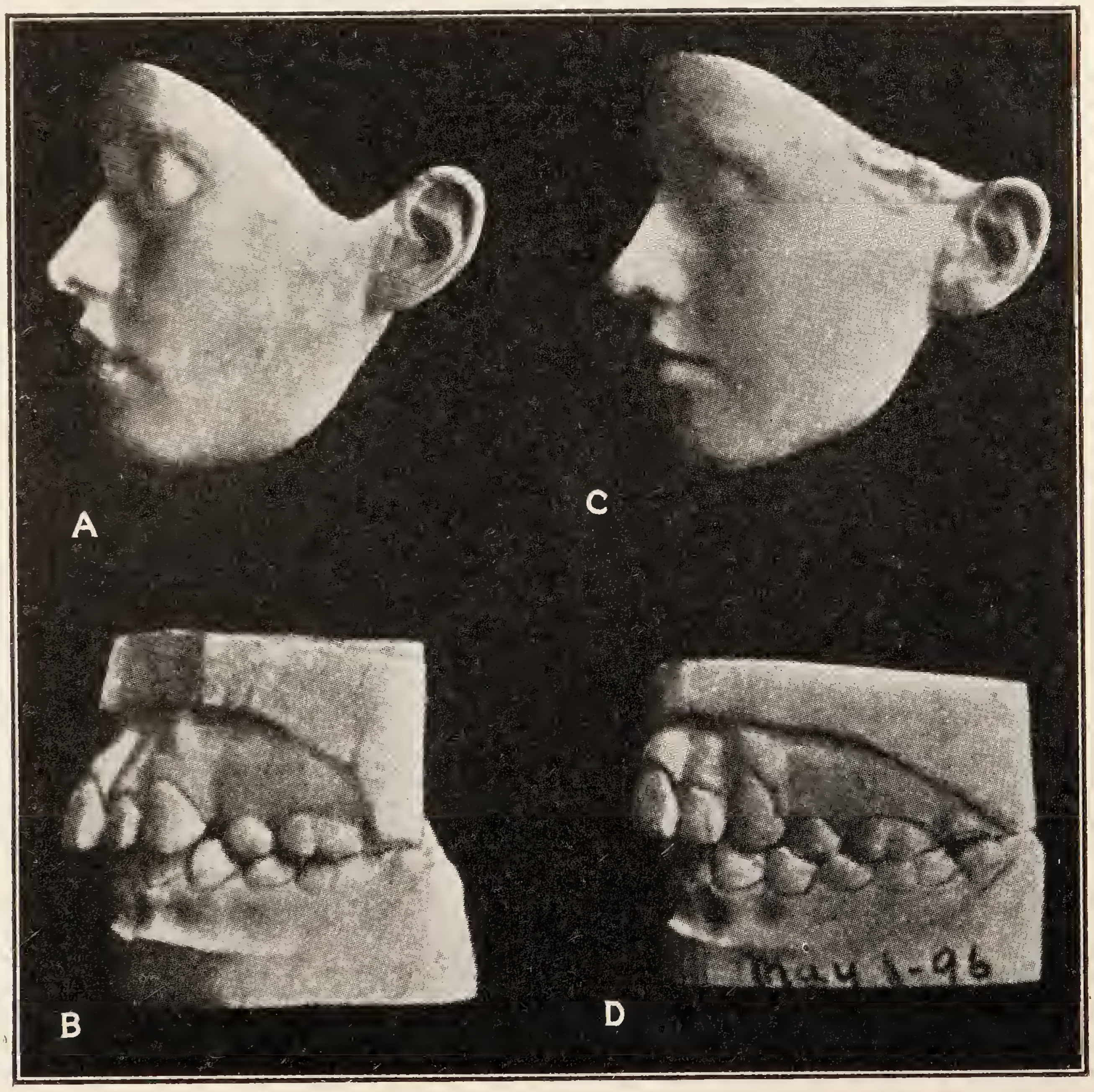
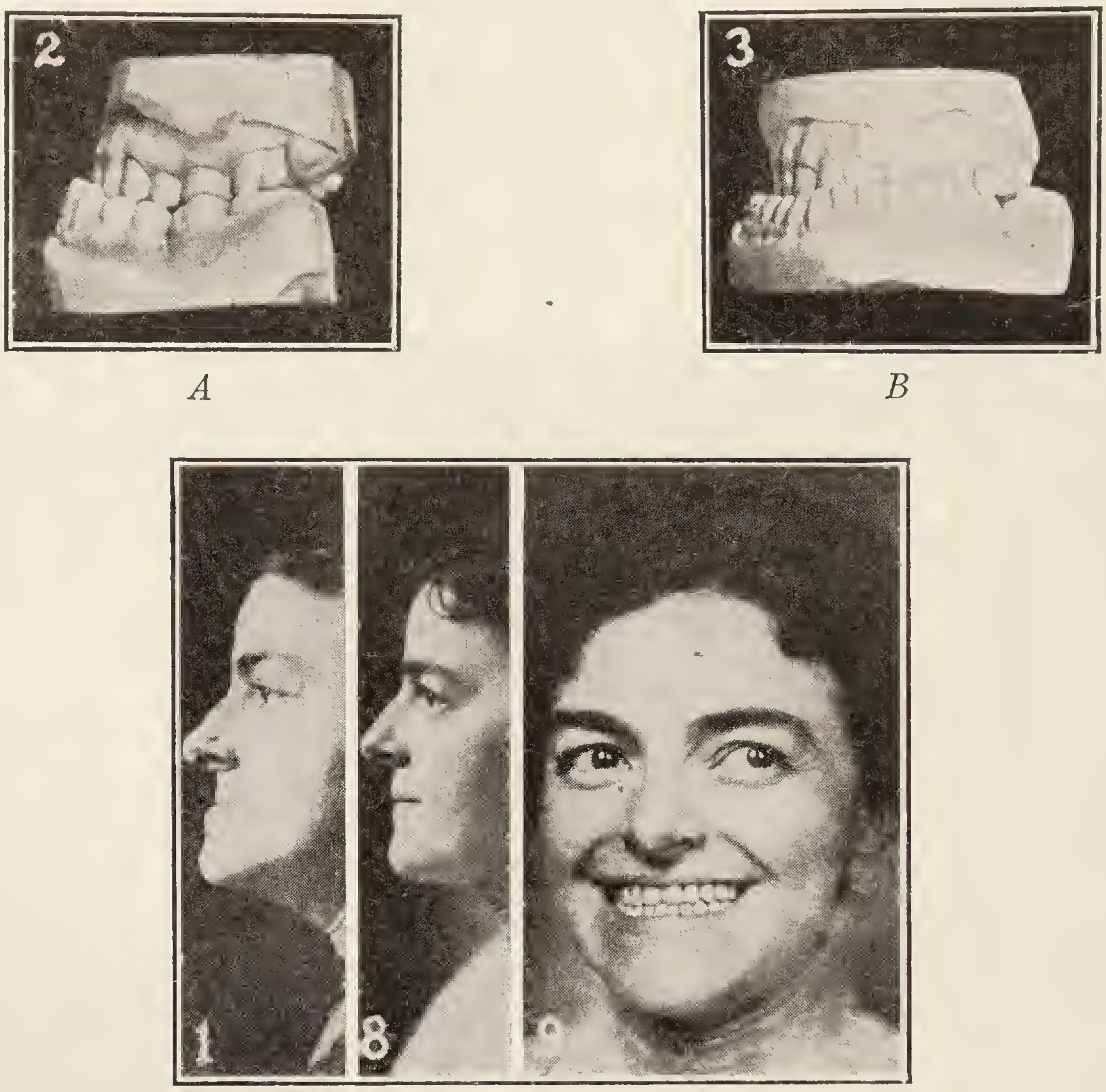


FIG. 840.—Illustrates an abnormal protrusion of the upper teeth and maxillæ. *A*, The lips fail to meet; the upper incisor teeth are very prominent and exposed to view; they lap over the lower lip. *B*, Plaster cast showing extent of protrusion. *C*, Protrusion corrected by orthodontic methods. *D*, Cast showing protrusion corrected. The teeth meet normally. (*Case.*)

ingenuity and an esthetic sense of the highest order. The world owes a great debt to the orthodontist. His mission is not only to regulate teeth and convert an ugly mouth into one of beauty, but it is to prevent deformities

of the face and remove them when they have developed. It is not possible to enter into the consideration of orthodontia in this work. Volumes have been written by masters in this field of surgery. However, I cannot refrain from referring to the great work of specialists whose lives have been devoted to correcting facial deformities. Herewith I present a figure illustrating the extent and variety of deformities of the face corrected by a slow process



A *B* *C* *D* *E*

FIG. 841.—*A*, Plaster cast showing the malocclusion of the teeth in a case of prognathism. The lower teeth overlap the upper. *B*, Front view of the same cast. *C*, Profile view of the patient before treatment. The chin protrudes and the lower lip is prominent while the upper lip apparently recedes. *D*, Profile view of the patient after the deformity has been corrected. By the skill of the orthodontist, this face has been converted from the asymmetrical, bull-dog type into one of perfect symmetry, and the lines of beauty have been established. *E*, Front view of the same patient. (*Dr. Gordon White.*)

of moving the bones into normal anatomical relations (Fig. 840). The orthodontist has converted the parrot face with retreating chin and over-hanging maxillæ into a normal, well-developed contour. He has devised instruments and apparatus with which to correct the protruding bull-dog mandible, thus removing one of the greatest facial deformities (Fig. 841). He has taken from the face its most conspicuous asymmetry and substituted lines of beauty. This field of surgery, though recognized, is not taught in schools of medicine, and it is here that the work of prophylaxis finds one of its most important expressions. It is the duty of every physician to understand the principles which underlie the cause of deformities and familiarize himself with the means

of prevention. A receding chin may be congenital; protruding bones may exist at birth; but the great majority of deformities of the facial bones are due to carelessness or ignorance on the part of the parents, who should be properly advised by the attending physician. The time has passed when the physician can ignore giving advice to parents regarding the development of the teeth and the evils which result from disease, displacement, deformities and other forms of irregularities. Inspection of the school children of the

FIG. 843.—Rubber prosthesis mandible. (*Schröder.*)

United States has revealed the prevalence of disease of the bones, of the eyes, of the teeth and of nearly all the other organs. Is it not true that many of these children have been permitted to get into an unfortunate condition by the family physician, whereas, if he had done his full duty, many of these defects might have been prevented?

Materials Used.—Among the materials used for the purposes of prosthesis are the following:

Rubber.
Gutta Percha.
Celluloid.
Metal.
Bone Tissue.
Fibrin.
Ivory.

Paraffin.

Sponge grafting.

Rubber is one of the most valuable materials and one universally employed. Its application to the needs of the surgeon, in meeting the requirements in prosthesis, is inestimable. It is molded easily into any form and, when vulcanized and polished, it may be used to replace lost tissues with as great a degree of satisfaction as any material at our command. When used as a substitute for the mandible, either entire or in part, it causes no irritation to the surrounding tissues and may be relied upon to serve the purpose satisfactorily (Figs. 842 and 843).

Gutta percha may be warmed, pressed into a mold, chilled and made ready for use without the delay attendant upon vulcanizing. Though gutta percha is not as smooth and hard as rubber, nor is it stiff enough to be used

Fig. 843.—Prosthesis to replace loss of maxilla (left side). (*Schröder.*)

as a substitute for an entire mandible, its principal advantage is the ease and rapidity with which it can be prepared. Plugs of gutta percha may be made to use in the antrum temporarily or permanently. The smoothness of rubber makes it advantageous from a hygienic point of view.

Celluloid has been used in place of rubber, but it has no advantages.

Gold, platinum, silver, tin, German silver, aluminum, nickel, irridium, copper, steel and many other metals have been used in prosthesis, each in its place serving well the purpose for which it is employed.

Modern surgery has made the use of *bone* possible as a substitute for a lost part. The bone graft that does the work most satisfactorily is that taken from the individual in whom the bone is planted.

Ivory has long been employed as a means of fastening bone and a substitute for bones which have been lost by disease or trauma.

Dr. Gersunny of Vienna brought *paraffin* prominently before the profession as a substitute for lost parts. It is of great value in restoring contour of features (Figs. 844 and 845).

Sponge Grafting may be accomplished by raising the depressed skin, laying beneath the surface a sponge which has been made absolutely aseptic,

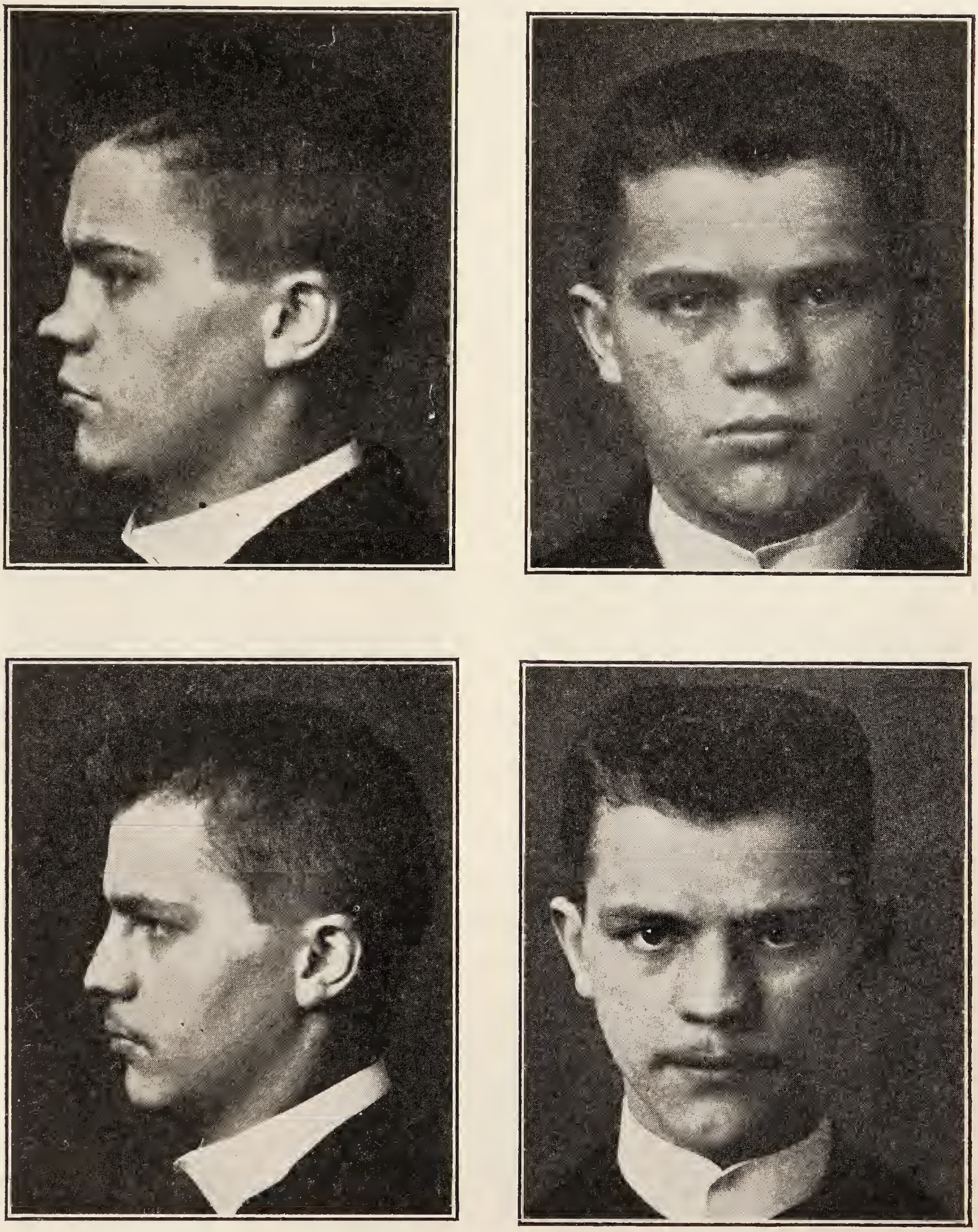


FIG. 844.—Traumatic saddle nose treated by paraffin injection. (*Eckstein.*)

and the wound closed. Granulations will find their way through the interstices of the sponge, which will become absorbed later and the depression removed.

IMPRESSIONS

Method of Taking Impressions.—The most reliable material with which to take an impression is plaster of Paris, which may be mixed to the consistency of thick cream. The addition of salt, in the proportion of one dram to a pint of water, hastens the setting. Taking impressions of the mouth, in cases requiring prosthesis, is often attended by a great deal of difficulty. Only an expert dentist is capable of performing this work in an accurate manner. Irregularities, grooves, depressions and, oftentimes, teeth arranged at different angles add to the complications of procuring an accurate impression. So-called modeling compound is often used. It makes a good impression,

FIG. 845.—Hereditary luetic saddle nose treated by paraffin injection. (*Eckstein*).

providing it has been made just soft enough by the proper degree of heat. If it is too cold and too hard, it will not make a sharp impression. If it is too soft, it will not work well. If not cool enough before it is removed from the mouth, it will bend and thus make an inaccurate impression. Yellow wax may be used more satisfactorily in prosthesis than modeling compound. It does not bend as easily and, therefore, may often serve the purpose better.

Making Casts.—If the impression is made of plaster of Paris, it should be dried, varnished and oiled. Fresh plaster is poured on the impression and built up to the proper height to give it strength and allowed to set until it becomes hard, after which it may be separated, trimmed and varnished for the construction of the appliance. If modeling compound or wax has been employed, the plaster may be poured into the impression, as described in making a cast from a plaster impression. The form is then trimmed and set aside to dry, after which the impression may be warmed and easily removed from the model.

FIG. 846.—Appliance for the restoration of the symphysis of the mandible with removable bridge-work retainers. In gun-shot wounds in which the symphysis or other portions of the mandible are carried away, this prosthesis may be used. Implantation of bone should always be given preference, however. (*Schröder.*)

Fig. 848.—Part of mandible replaced by vulcanite rubber and retained by removable bridge attachment. (*Schröder*)

FIG. 849.—Prosthesis with ball-and-socket joint for resection of the mandible, complete or partial. (*Schröder.*)

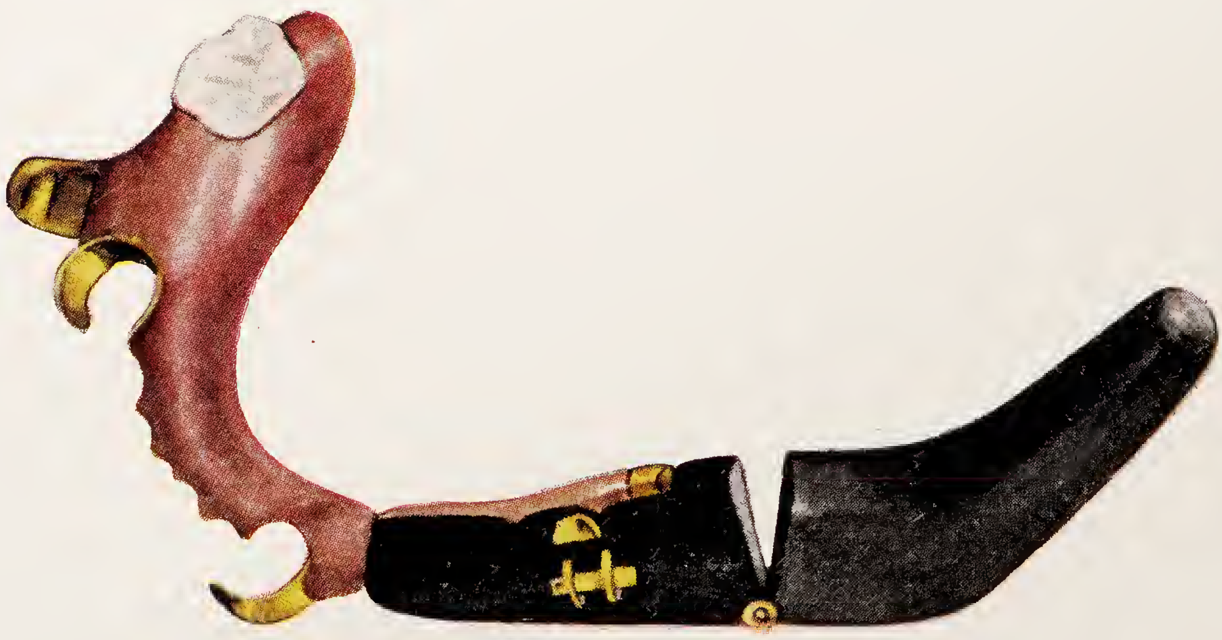


FIG. 850.—Partial restoration of the mandible with lower plate attachment. (*Schröder.*)

of constructing appliances for replacing lost parts—prosthesis—as the department of technology in a well-equipped, modern school of dentistry. The work of carving, casting, swaging, vulcanizing, molding and finishing together with a knowledge of the anatomy of the parts to be supplied, enables the operator to reproduce lost parts and meet the esthetic requirements. It is not the province of this chapter to describe in detail the methods of procedure in giving form to the different materials employed in constructing these appliances. It is sufficient for our purpose to explain the use of the constructed prostheses and the manner of adjusting them.

Fig. 847.—Black rubber prosthesis substituted for a large piece of the body of the mandible on the left side. This prosthesis was made to replace the bone, following its removal for a malignant tumor.

Indications for Use.—A loss of the whole or a part of the mandible so changes facial expression that measures looking to its replacement must be considered of inestimable value. Gun-shot wounds (Fig. 846), carrying away a part or the whole of this bone, malignant tumors (Fig. 847), necrosis, and other maladies which lead to its disintegration, make the restoration of facial contour necessary. The maxillæ, from disease or injury, may be lost, when artificial substitutes become a necessity. It is especially desirable that the most approved method of constructing and adjusting substitutes be well understood. A few ingenious men only can be relied upon to devise and adjust

prosthetic appliances. The mandible is a very important bone. Its function is to make mastication possible, assist deglutition, aid phonation and add character and expression to the face. Its absence in part leads to asymmetry of the features, the chin is diverted from the median line and the teeth upon the remaining side fail to occlude, therefore, the patient is unable to masticate his food and is ever conscious of his deformity. If the entire mandible is lost, the patient is deformed beyond recognition. Besides, the acts of swallowing and of speech become extremely difficult. The desirability of substituting an artificial appliance for partial or complete restoration of the features, therefore, is apparent when a resection of a portion or the whole of the body of the bone is made (Figs. 848 to 850). To prevent a change in facial expression, and the deformity which ensues, a substitute should be placed within the tissues to support them and, at the same time, give motion to the parts.

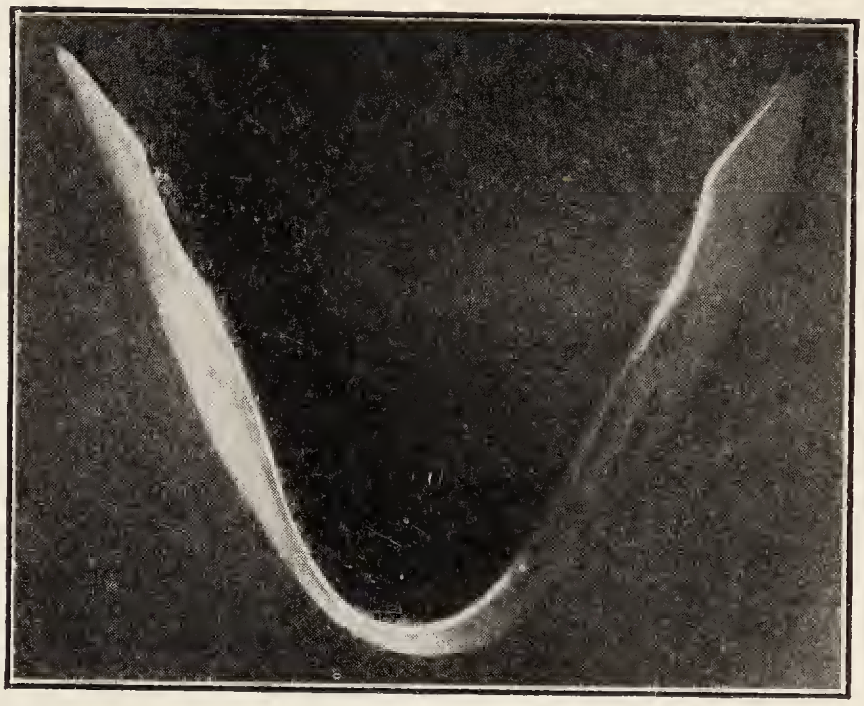


FIG. 851.—Metal jaw used as a substitute. (*Schröder.*)

Adjustment.—As nearly as possible the materials should be the counterpart in form and size of the bone removed. They should give to the face normal contour and expression. The material to be adjusted should be prepared after taking careful measurements of the bone as to the width between the glenoid fossæ, the width between the two first molar teeth, the length from the glenoid fossa to the angle and the length from the angle to the symphysis, after which the bone may be removed. These measurements will enable the operator to construct an entire mandible that will take the place of the one removed (Fig. 851). Should only a section of the mandible, involving a tumor, or from any other cause, be removed, the distance between the areas of healthy tissue may be estimated, a piece constructed with a liberal allowance so that, if need be, a portion may be sawed off, and the piece thus made to fit (Fig. 847). In the adjustment of these appliances, little irritation follows, the parts do well and the symmetry of the face is preserved. Efforts at

reconstruction of the jaw by plastic surgery have proven most unsatisfactory. Recently sections of bone from the tibia have been successfully implanted. In this connection it may be stated that it is essential in the implantation of bone as a substitute for a section of the mandible, to perform the operation extra-orally and to avoid entering the oral cavity. The danger of infection from the oral secretions entering the wound renders the intra-oral route hazardous. The rib is sometimes used to replace a portion of the mandible, but the spine of the tibia, which has a thicker surface of compact bone, has proven more reliable (Fig. 852). Making measurements of the face and preparing the appliance for substitution are essential prior to the removal of the bone.

FIG. 852.—Implantation of a section of rib to compensate for the loss of a portion of the mandible.

The substitute should be adjusted at the time of operation. Failure to do this will lead to the formation of cicatricial tissue and adhesions, which will render the adjustment of the prosthesis extremely difficult and, in some instances, impossible.

The Need of Better Knowledge.—The art of surgical prosthesis, as applied to the injuries, diseases and malformations of the mouth and associated parts, has not been developed to the extent that its importance demands. Supplying parts lost by disease or trauma is not possible for the surgeon, with few exceptions, and the dentist is not trained in the construction of these appliances. This field, therefore, is uncultivated, much to the detriment of those

who require this form of surgical prosthesis. The dentist has at his command all of the facilities, material, knowledge of manipulation and capacity to mold these materials into any form desired to take the place of lost parts, but the patient, who has sustained an injury or suffered from disease with loss of tissue, rarely applies to the dentist for his services. The surgeon, not being prepared to do the work required, too often permits the patient to remain deformed for want of proper treatment. The few dentists, who are skilled in the construction of such appliances, are not in sufficiently close touch with the surgeons to co-operate with them in this important work. It is gratifying to know that in Germany the interest which the surgeon shows in the work of the dentist in the construction of such appliances has brought about most cordial relations, which have led to a higher and more successful application of the art.

In a work recently issued by Dr. Hermann Schröder of Berlin,[1] speaking

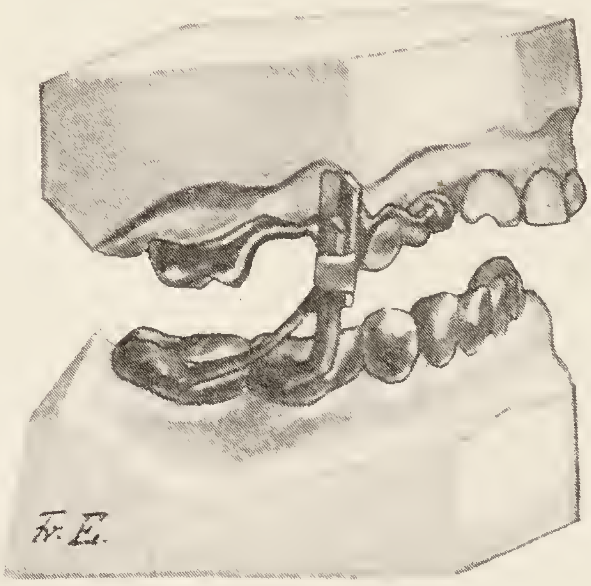


Fig. 853.—Sliding appliance to hold fragment in place until cicatrization is completed. (*Schröder.*)

of the few dentists who have endeavored to construct artificial appliances for lost parts, he says:

"Even those few dentists have had to contend with great difficulties because of the lack of interest on the part of the surgeons for the art of dental prosthesis. Claude Martin in France and Suersen and Sauer in Germany had to overcome great obstacles in order to cultivate this ground systematically. They have to thank only their tenacity of purpose, their perseverance and the excellence of their work for the recognition they gained from great schools of surgery. They have smoothed the path for their disciples and followers, and today, when dentistry is about to be recognized as a full-fledged branch of medicine in general and when almost every surgical clinic of any pretention endeavors to secure dental collaboration, it behooves us to especially honor and appreciate the inheritance of these men, for, of all dental work in hospitals, dental prosthesis still secures for us the greatest successes

[1] "Manual of Dental-Surgical Bandages and Prosthesis," in Vol. I, "Fractures and Luxations of the Jaw-bone."

and warmest recognition and it may, with satisfaction, be stated as an established fact that of late the interest shown by surgeons for this important department of our branch of science and art is steadily on the increase.

Whoever, therefore, intends to become a dental surgeon in a hospital should become thoroughly versed in everything that hitherto has been achieved in this particular field. Frequently, he will have the opportunity to supplement and, in numerous cases, to render more perfect the surgeon's work, for plastic surgery, despite its enormous progress and splendid success, cannot exceed certain limitations. Especially, in regard to the face and the

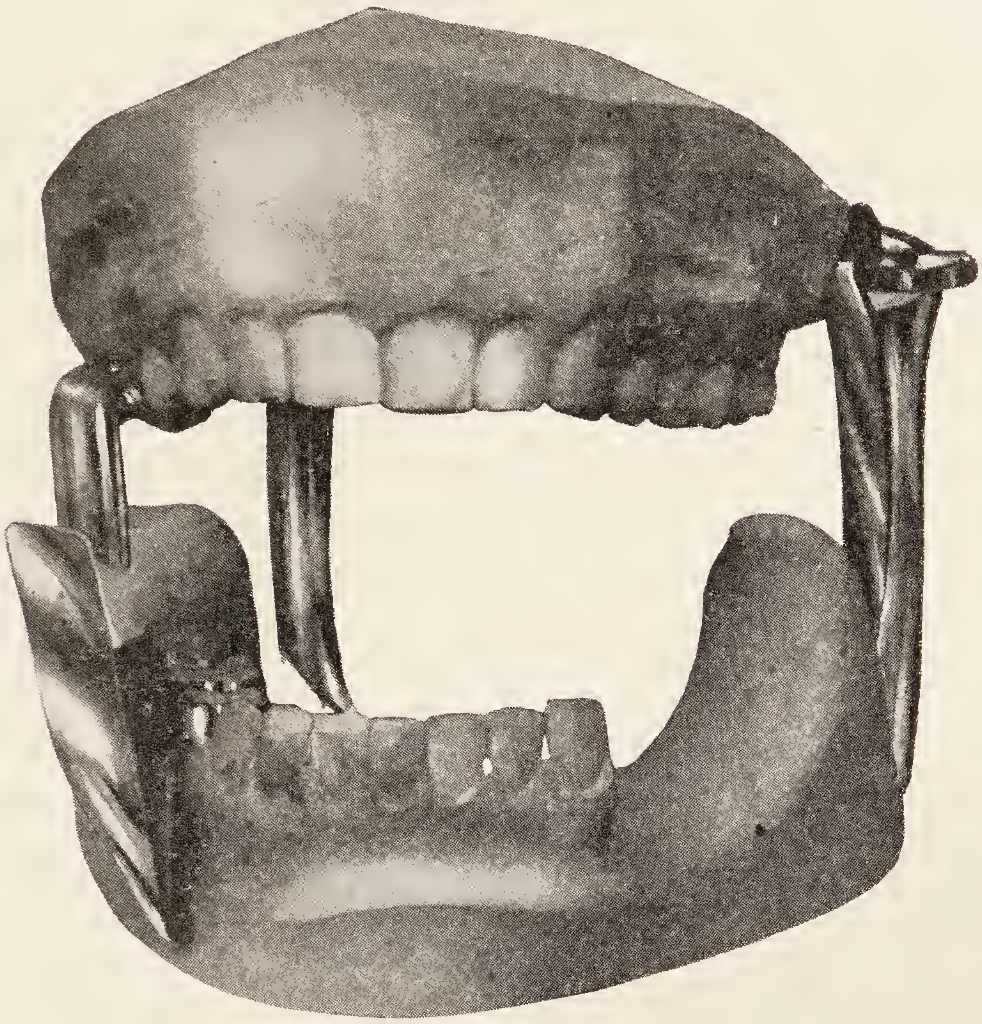


Fig. 854.—Illustrates a very reliable appliance (Martinier) for holding the mandible in proper relation with the maxillæ following the removal of a section of the bone. It is essential to prevent loss of normal occlusion of the teeth, which always occurs through the action of the genio-hyoid-glossus and the anterior belly of the digastric muscles. This appliance has two planes, the lower telescopes outside of the upper. By this device, occlusion of the lower with the upper teeth is made certain. The appliance is kept in place until cicatrization is completed. It is used when prosthesis is not permissible.

cavity of the mouth, it is often impossible to remedy an existing defect by plastic means. Then the only recourse left is prosthesis and excellent results can be achieved not only cosmetically, but functionally. Besides the known and excellently working pharyngeal plate, the total or partial replacement of the jaw bone must be mentioned in this connection. Dentists have even made successful attempts to replace the larynx. The dental prosthetic art proves just as successful in remedying facial defects, which frequently have to do with the cavity of the mouth.

Though much successful work has already been done in this field, it has

not as yet led to a well-ordered and methodical establishment of the possibilities for treatment and replacement. In this respect much is yet to be done.

The further development of dental-surgical prosthesis is dependent upon the systematic collaboration of surgeon and dentist. Only in this manner may further experiments lead to the creation of new and more efficient methods of treatment. Each individual case should be discussed and considered in common and it seems especially desirable that an understanding between the surgeon and the dentist should be reached in regard to the plan of operation in order that the work of the dentist may not conflict with that of the surgeon. The surgeon, who calls a dentist into a case, should, in planning and executing the operation, take into consideration—as far as can be done without jeopardizing the healing process—the prosthetic measures to be taken either immediately after the operation or later on. He does the same thing in connection with other operations, as, for instance, when amputating lower limbs, where he does not shun the sacrifice of extensive healthy parts in order to provide the possibility for effective replacement.

The success and effectiveness of our prosthetic work depend largely on the location, form and extension of the defects, and on whether the esthetic feeling is chiefly to be served thereby or whether it is merely a question of the re-establishment of functions, or whether both purposes must be combined. In the present status of dental-surgical prosthesis, however, we find a limit to their method of application. Prosthesis is resorted to independently either in order to equalize some defect in regard to form and function, or it is carried out in connection with an operation for the purpose of furnishing a firm, properly shaped foundation for the execution of a plastic operation (giving the required support and also a pleasing form to those parts of the skin and tissues destined to cover the defect) or, in connection with some incisive and maiming operation, to replace what cannot be surgically replaced. From this point of view it becomes possible and will serve a good purpose to tabulate and group the various methods of prosthesis that may be applied. The question as to when prosthesis alone should be resorted to, when it is better to leave the field to the surgeon's plastic art, and where it should walk hand in hand with the latter, should be thoroughly discussed by surgeons and dentists. As in the case of the amputation of limbs the plastic art stands back almost entirely, leaving it to prosthesis to cover the loss of substance, so there are defects in the face and in the cavity of the mouth which plainly require exclusive prosthetical treatment, standing in contrast to those which may be treated either plastically or prosthetically, or which may be equalized by a combination of the plastic with the prosthetic art.

Not only in regard to replacement does technical dentistry render valuable service to the surgeon; it furnishes him well-adapted bandaging for fractures of facial bones, especially for fractures of upper or lower jaw-bones; it insures lasting success for plastic operations by constructing and applying supporting

and stretching apparatus; and it makes possible effective occlusive bandage for the surfaces of badly healing wounds, for the surfaces of ulcers and for still-developing defects in the cavity of the mouth.

Thus we have, between surgery and technical dentistry, an important frontier district, rich in problems. Undoubtedly, in consequence of the introduction of the dentist into hospital clinics, this field will be cultivated more thoroughly than before."

CHAPTER XLI

INFANT FEEDING

BY

F. W. BELKNAP

The various means of introducing food into the stomach of a child with cleft palate have been described in another chapter, so that it remains for us to outline rather briefly the general principles which are to guide us in feeding the infant. It is not possible in a restricted space to give either all the data which have accumulated or the more or less scientific basis from which they may have been evolved.

Mother's Milk.—It is an established fact that in by far the greatest number of cases it is easiest and best to rear the infant on mother's milk. When that is not possible (a contingency arising much less frequently than some authors would make us believe), it would be of great advantage to have some human milk at the disposal of the infant, particularly during the first months of its life. Unfortunately, the difficulties of obtaining suitable wet nurses are so great that only a few cases can be supplied. In some cities there exist institutions where bottled breast milk can be obtained, but even where none exist, it is possible, with some effort, to obtain human milk.

Since it is understood that our first object is to give the infant the benefit of the mother's breast, we will occupy ourselves with the technic of nursing. Only too frequently are we told that the mother's milk does not agree with the infant and, therefore, it has to be taken off the breast and started on artificial feeding. While this may be true now and then, in the great majority of cases a little close scrutiny will reveal the fact that the failure was not due to the unsuitable quality of the mother's milk, but to faulty management in the nursing. The most potent stimulus to obtain a sufficient supply of milk is the sucking of the infant.

When to Start Infant Feeding.—An infant is put to the breast first in twelve to twenty-four hours after birth. As a rule, lactation is established on the third or fourth day. In some instances it may not occur before the end of the first or, even, the second week, therefore, the efforts toward establishing a sufficient lactation should not be given up prematurely. When the lactation is delayed, we may have to resort to additional feedings for some time, besides giving water. This feeding should be kept at as low a level as possible. Usually it is sufficient to give 50 to 60 cc. of cows' milk, diluted in the proportion of one part of milk to two parts of water, either at regular intervals or after each nursing.

Hours of Feeding.—From the start it is well to observe regular nursing intervals, keeping in mind that our régime may have to be changed to suit the individual. It is best to try a four-hour interval, with not more than six feedings in twenty-four hours; for instance, 2, 6 and 10 A.M., 2, 6 and 10 P.M., offering the baby water in addition. It is preferable to alternate breasts with the meals and to give only one breast at a feeding. The advantage of such a regime is that it is much less exacting upon the mother, which is very important since it offers her a chance for rest and recreation. Indeed, under such an arrangement many more mothers would be willing to nurse their babies. Furthermore, it is of equal benefit to the infant, minimizing the dangers of over-feeding. Sometimes it may become necessary to increase the number of feedings, but hardly ever will it be found necessary to give more than eight in twenty-four hours.

Duration of Each Nursing.—The duration of the single meal may be left to the baby, as a rule, particularly if this is done from the beginning, since the baby knows perfectly well when it is satisfied. It loses interest in the nursing, plays with the nipple instead of sucking, and is ready to go to sleep. It is one of the cardinal rules not to induce the baby to further efforts when these signs manifest themselves. The duration of the single meal may vary between five to twenty minutes and very rarely is the latter time exceeded.

Stomach Capacity.—Under a régime as outlined above, it is evident that the single meal will exceed the stomach capacity of the infant. The size of the stomach has been emphasized frequently as of great importance in determining the permissible amount of milk introduced at a meal. While its size may not be disregarded entirely, nevertheless the records of babies of good development should warn us not to lay too great stress on this point. These babies do well on meals exceeding the stomach capacity. The following table illustrates this point:

Age	Stomach capacity		Amount taken at a meal		Number of meals
	Holt	Pfandler	Average	Maximal	
2 weeks..........	40 cc.	....	90 cc.	138 cc.	6.2
4 weeks..........	64	90 cc.	110	160	6.0
8 weeks..........	108	100	140	216	5.8
12 weeks..........	144	110	146	239	5.7
16 weeks..........	160	125	154	267	5.5
20 weeks..........	....	140	172	265	5.3

The figures for the size and number of meals were taken from a number of cases reported in the literature where the amount of milk taken by an infant was determined at each nursing for a protracted period of time and where the babies developed very well.

Another reason which has been advanced in favor of frequent feeding is this, that the stomach of an infant is found empty one and one-half to two

hours after a meal. This is an excellent reason for not feeding more frequently, but there is no reason at all for feeding when the stomach is empty. That the stomach capacity need not determine the size of the single meal is very evident from the fact that part of the milk leaves the stomach while the nursing is in progress. Of the various factors governing the emptying of the stomach we may mention one: the state of filling the small intestine, inasmuch as this factor could easily explain the good results obtained with various régimes. If a baby is fed every two hours, the small intestine will not have time to empty itself as well as when longer intervals are adopted,

FIG. 855.—Illustrating the use of the Brophy rubber velum for closing the open space in a cleft palate. The mother holds the velum in place by the handle enabling the child to nurse and easily swallow its food. The velum can be used until the soft palate is united. (See Fig, 407.)

consequently, less milk will be taken. Regurgitation or other disturbances will be more frequent. On longer intervals, the small intestines have time to discharge their contents and more milk leaves the stomach during nursing, thus permitting the introduction of a larger amount.

Difficult Feeding Cases.—Where the establishment of the lactation is beset with difficulties and when the presence of a weak or vigorous infant, or one to whom the duration of the nursing cannot be trusted, require deviations from the rules, the necessity of expert advice cannot be dispensed with. While under normal conditions lactation will be sufficient under the above

régime, in cleft palate cases the baby sometimes cannot be put to the breast satisfactorily in spite of the various devices employed (Fig. 855). Here the milk has to be withdrawn and we lose the most potent stimulus for either establishing lactation or keeping it up. In order to establish and keep up lactation, it is best to put a normal infant to the breast. Where this is not possible, we have to resort to the breast pump. With the best of these, the mother applies the suction intermittently by means of a tube connected with the glass nipple (Fig. 856). In all cases where the breasts have to be emptied

Fig. 856.—A simple breast pump which is easily made. (*Amer. Jour. Dis. of Children.*)

artificially, skillful management is essential. Milking the breast by hand is frequently more successful than pumping. The areola is taken between the thumb and first finger, the breast drawn gently forward and downward with slight pressure, then released and the motion repeated. While the different methods will not be successful at all times, in many instances the supply of milk is sufficient for the demands of the baby.

Management of Breasts.—Whatever method is employed, great care must be taken to prevent breast lesions. The apparatus should be boiled in water for twenty minutes and the breast itself should be washed with sterile

gauze and water to which a little alcohol may be added. This should be done before and after milking. It is well at all times to wear a piece of sterile gauze over the nipple and adjacent parts. When the breast is manipulated, the hand should be washed with soap and water and finally rinsed with sterile water. Should any excoriation of nipple or adjacent parts occur, it may be touched with a six to ten per cent. silver nitrate solution and then washed with sterile one per cent. sodium chloride solution. An ointment much used is one containing silver nitrate one per cent., balsam of Peru ten per cent. and vaseline eighty-nine per cent. Others recommend a solution containing three per cent. tannic acid, twenty per cent. glycerin and seventy-seven per cent. alcohol. When associated with much pain, dusting with orthoform has proven valuable.

In order to be able to detect and correct errors in the technic of nursing, one has to pay attention to several factors. The most common mistake is overfeeding, particularly when a baby is fed according to some rigid plan as outlined in many books without paying heed to its individual demands. For instance, a feeding is given every two hours and the baby kept on the breast for fifteen to twenty minutes. At first the baby gains weight very rapidly, sleeps well and the bowels are in good condition. Then the weight becomes stationary or there is even some loss. The baby cries much, is fretful, maybe vomits more or less frequently, while the stools increase in number, their color and consistency change and more or less mucus appears. Often it is claimed then that the breast milk does not agree with the baby and it is changed to artificial feeding. This is a serious mistake as all that is necessary is to put the baby on a restricted diet. Here, again, it becomes necessary to keep in mind the baby as well as the source of the milk supply. As far as the baby is concerned, the interval between feedings is lengthened and the time of feeding shortened. For instance, instead of feeding every two hours the intervals are changed to four hours, with a nursing time of three to ten minutes, according to circumstances. It must be remembered that the baby receives more milk in the first few minutes than later on. During the first five minutes it may receive as much, or more, as in the following ten minutes. Furthermore, with the normal breast the composition of the milk undergoes a change during nursing, the most important being the gradual and constant increase in fat. However, this is not always the case. Where the milk supply is very abundant, the fat content rises at first, becoming stationary for some time, to rise again at the end. In other instances, after reaching a certain point it finally drops. With regard to the mother, it is very important that not too great a residue of milk is left in the breast. The breast readily adapts itself to the demands thrown upon it. Frequent nursing, particularly when the baby is made to empty the breast thoroughly, leads to an abundant supply of milk, whether this be of benefit to the nursling or not. If the nursings are reduced in frequency, too much milk may be left in the breast. Under such conditions the milk is

likely to revert to a colostral character and finally stop entirely. It is very important, therefore, to guard against milk stasis by removing the excess of milk from the breast, either by the breast-pump or by manipulation. As a rule, pumping will not be necessary for more than a few days or a week, when the breast will adapt itself to the new demands. How important the prevention of milk stasis is may best be seen by the experience gained in institutions which supply wet nurses. It was found that a woman having nursed two or three babies successfully was returned after a week or two because her milk had given out. The reason for this occurrence is obvious. Even when the production of milk has ceased, it may be re-established by persistent effort at nursing after the lapse of a month or more.

Controlling Mother's Milk by Diet.—Here we may discuss briefly the hygiene of the nursing woman, particularly with regard to diet and exercise. As a rule, it is best to make no great change in the mode of life to which the nursing woman has been accustomed. It is of no benefit to change the diet of a woman accustomed to rather coarse fare to one of a more refined and rich nature. The result may be an indigestion, with consequent disturbance of the lactation. Neither is it well to confine too closely to the home a woman accustomed to exercise or work. Sometimes, where the milk has been found too scanty in amount, a careful increase in the amount of food should be given, preferably in the form of milk. It has been claimed that the administration of such highly nutritious preparations as maltropon is of beneficial influence. If the milk supply is too abundant, the food, particularly rich proteins, may be restricted and some exercise given in the open air. Where the fat content of the milk is too low, food rich in proteins is advised, although the fat content of the milk can be raised from a low level to a higher one, up to a certain point, by the administration of such food as cream and bacon. If the milk contains too much fat on a diet rich in proteins and fats, it may frequently be reduced to a proper level by excluding those articles given for the purpose of aiding the lactation and introducing a larger amount of water.

Collecting and Testing Mother's Milk.—The points just raised entail a chemical analysis of the breast milk. The normal composition is as follows:

Proteins	1–1.5 per cent.
Fat	4.0 per cent.
Sugar	6–7 per cent.

The method of obtaining the milk for analysis is just as important as the analysis itself. It is but a waste of time to examine a single sample of milk obtained at random. An ideal method of obtaining the milk for analysis would be to withdraw a twenty-four hour amount of the milk, analyze a specimen of this, and feed as much of the rest as is desirable, but this is rarely applicable in practice. With the baby at the breast, the following procedure is the most satisfactory: Before and after each nursing in the twenty-four hours, an equal amount of milk is taken, all the samples are mixed, and this

examined. Each time only a little milk need be taken since a total of about 30 cc. is amply sufficient for all the necessary tests. For determining the milk fat, 5 cc. is sufficient.

Drugs Passing Into Milk.—A few words may be added with regard to a number of drugs passing in the milk, such as salicylic acid, antipyrin, etc. Some pass particularly when given in fatty vehicles as the iodin preparations. On the whole, the amount of drugs entering the milk is not very great and they may be given in moderate doses with safety. Alcohol passes rather readily and alcoholic beverages had better not be taken by a nursing woman. It is of interest, in this connection, that certain immune bodies pass into the milk. Morphin interferes with the production of milk.

Contra-indication to Nursing.—Of the contra-indications to nursing, we may mention any disorder likely to endanger the life of the infant, as drunkenness or convulsive attacks, like epilepsy. Tuberculosis of the mother is also regarded as one of the absolute contra-indications. On the other hand, certain infectious diseases, like pneumonia, influenza, even uncomplicated typhoid fever, diphtheria, etc., do not constitute a contra-indication to nursing, but they require a careful handling of the baby so as not to expose it to the infection (washing of hands and breast, covering the infant with a cloth, etc.). Neither does a mastitis not broken through into the milk-duct necessitate the removal of the baby from the breast. Indeed, under such conditions, a continuance of nursing is advisable in order to keep up the flow of milk. At the same time, the normal breast-fed infant is known to possess a rather great resistance to infections. The return of menstruation can be neglected. Renewed pregnancy will, as a rule, prompt the transition to artificial feeding sooner or later, although there are instances where the new baby simply replaced the older one on the breast.

Wet Nurses.—Naturally, all the points discussed thus far pertain alike to a mother and a wet nurse. In employing a wet nurse it is well, as a rule, to select a woman between twenty and thirty-five years of age, who has shown her efficiency as a milk producer for about six weeks. The period of lactation is of no consequence. The best means to judge the ability of a wet nurse is her own baby, which should be permitted to nurse also, particularly where her charge is rather feeble. The wet nurse should be free from venereal diseases and not be employed without previously making a Wassermann test. Neither is it permissible to expose a healthy wet nurse to a syphilitic child. In the latter case, and when there are obstructions to nursing as in cleft palate, the milk may be withdrawn and fed from a bottle. Under such circumstances it is usually desirable that the wet nurse's own baby be put to the breast. It hardly needs to be mentioned that the wet nurse should be free from tuberculosis or other manifest diseases. Her position, from a social point of view, need not be discussed here.

Determining the Food Tolerance.—To return to the baby. Von Pirquet presented the fundamental facts concerning successful feeding in a clear and

simple manner. We take for granted that the composition of the human milk is a proper one. During the first months of life, with the exception of about the first week, we may accept one hundred grams of milk per kilogram of body weight as the amount of milk necessary to sustain the weight. On this amount, the baby does not gain weight, but it does hold its own. If we drop below this, it will lose weight. If we exceed, we achieve a gain in weight. Increasing the food, we see that this gain becomes greater in proportion to the amount of food given. On a further increase, however, the gain may continue, but not in proportion to the amount of food given in excess, and, finally, by still further increasing the food, the gain in weight stops or gives way to a drop if we persist in feeding these latter amounts. The amount of food yielding the relatively best increase in weight is the optimal diet; the amount of food which, on further increase, leads to a stand-still of the body weight, is the maximal diet. We see then that our feeding will be successful anywhere between the sustaining and the maximal diet. This determines the tolerance of the baby, the upper limit of which is formed by the maximal diet. Substituting average figures for these different diets, we may then go on the assumption that 100 cc. breast milk, or 70 calories of a well-balanced food constitute the sustaining diet; that about 150 cc. breast milk, or 105 calories, constitute the optimal diet, while 200 c.c. breast milk, or 150 calories per kilogram, mark the maximal diet. (The number of calories per kg. are designated as the quotient of energy.) In the example just given, it is seen that the latitude of tolerance is such that feeding the infant between ten per cent. and twenty-two per cent. of its body-weight may yield results. If we want to test whether the amount of food a baby receives approaches the maximal diet, we add, say, 100 cc. to the diet for a day. If the weight of the infant shows a corresponding increase, the previous diet has not been the maximal one permissible. While the tolerance of a given case may vary widely, we are less likely to err with regard to the sustaining diet in the average normal case. For therapeutic purposes this is the most important feature, for whenever the limit of tolerance is exceeded for any length of time, the values for maximal and optimal diets are depressed. For instance, suppose the maximal diet just mentioned has been exceeded, it will be found, on continuing this diet, that we get a drop in weight and we have to reduce the diet to 150 gm. per kg. in order to obtain a gain. This means that the diet, which formerly constituted the optimal diet, is now the maximal diet, while the optimal diet now lies between the sustaining diet and the new maximal diet. In such cases, *i.e.*, where the nutrition has suffered, it is the custom to drop immediately to the sustaining diet and gradually increase the food under control of weight, clinical behavior and stools. This scheme not only serves with advantage in breast-fed infants, but also in those raised artificially. It must be kept in mind that the limit of tolerance may be depressed not only by mismanagement of feeding, but by means of diseases as, for instance, measles, etc. Excessive feeding not only makes itself felt in the weight curve, but also in the

number and character of the stools, in the clinical behavior, oscillations of temperature, fretfulness, loss of sleep, vomiting, etc.

Determining Amount of Milk a Baby Receives.—The question now arises as to how we are to determine the amount of milk a breast-fed baby receives. This is easy enough when withdrawn human milk is given. When the baby is on the breast, it must be weighed before and after each feeding in the twenty-four hours, preferably for more than one day. It is absurd to weigh the baby only before and after one nursing, since the amount of the single meal is subject to entirely too great variations. Weighing the baby before and after each nursing will at once solve the question of over- or under-feeding; a question which, in little pronounced cases, is not so easy as it may appear on first sight. An infant not receiving sufficient nourishment will cry after feeding, but so will one in distress from too much food. In both cases offering more food will, for a while, at least, inhibit this crying. In both the weight may remain stationary or decrease. The children become fretful and lose sleep. The stools may become more numerous, loose, green and slimy in both cases. When the inanition becomes more pronounced, the character of the stools may assume a brownish color and change to peat-like consistency. The characteristic hunger stool is dark and of the same consistency. The similarity of the symptoms where over-feeding has been in progress for some time, with depression of the limit of tolerance, and where an insufficient amount of food is given may easily be understood. In the former, the infant cannot make use of the food and, from this point of view, it is in the same condition as the one which does not get sufficient food. The over-fed infant is even worse off, because the excess of food serves now as an injurious agent. It is for this very reason that we have to guard the infant so carefully against prolonged excessive feeding. Some infants, it is true, relieve themselves promptly of an excess supply of food by regurgitation, but this is by no means always the case and cannot be relied upon.

Normal Weight Increase.—The judgment of the success of the feeding presupposes a knowledge of the development of the normal infant which reaches its birth weight at about the tenth day. The following figures, it must be understood, are average figures based on a birth-weight of 3000 to 3500 gms. It must be remembered that an individual infant need not fall within this scope. In an individual case we may judge whether the gain in weight is satisfactory in various ways, using as a basis the birth-weight. The infant should double its birth-weight early in the fifth month and should treble it at the end of the first year. Taking these figures into consideration, an infant weighing 3000 gms. should weigh 6000 in the fifth month. This would mean a gain of 600 g. per month during the first half year and of about 500 g. the second half year. This is not exactly correct for the progress of weight is not uniform, the maximal period of growth coinciding about with the third or fourth week of life. The average gain for the first five months is as follows:

Months	1st	2nd	3rd	4th	5th
Per diem	29	27	24	16	15
Per month	868	872	716	489	460

Other Factors in Normal Infants.—At the period of the maximal growth, more of the breast-milk is utilized for building up the body than before or after. It must be kept in mind that in weighing the baby, the weight has to be taken at the same time of day. An ideal weight curve should show an uninterrupted gain while a stop in the gain of weight cannot be considered strictly normal. The gain in weight is not the only criterion for the development of the baby. It is necessary to pay attention to its general condition. The skin should be elastic, firm, smooth and of a rosy hue. The muscles should show a good tonicity. The temperature of the infant on constant outside temperature should not oscillate much more than 98.2–99° F. (36.8–37.2° C.). When awake it should be cheerful, show a tendency to move its limbs actively and pay attention to its surroundings, being easily detracted. The first few days the sleep should be almost continuous, quiet and rather deep, only interrupted by meals. During the first weeks of life, the infant sleeps about twenty hours, or more, of the twenty-four. During the first half year, it will sleep sixteen hours, or more, staying awake from one-half to two hours. With one year the total sleep will amount to about fourteen hours. The normal infant does not need any inducement to go to sleep, like rocking, etc., particularly when not unduly excited and the diaper is kept dry. The number of stools in twenty-four hours should be from one to three. They should be homogeneous, of ointment-like consistency, yellow in color and acid in reaction. Microscopically, detritus, a few fat globules, fatty acid crystals and bacteria are seen, most of the latter being gram positive and growing in an acid media. The most prevalent form is bacillus bifidus communis, Tissier. The gram negative forms, like bacillus colon communis (Escherich) are numerically less. The amount of urine excreted in twenty-four hours after about the first week is approximately sixty-eight per cent. of the fluid ingested. It is of low specific gravity, about 1003, and acid in reaction. It may be of interest to note a few peculiarities of the urine of the normal breast-fed infant. According to Moll, the twenty-four hour urine of a normal, breast-fed baby does not contain more than 10 to 20 mg. P_2O_5. Taking 10 cc. samples for examination, the amount of P_2O_5 is so small that he designates such urine as free from phosphates.[1] Furthermore, it has been shown that the urine of the normal, breast-fed infant is free from glycuronic acid, nitrates and nitrites. The test for these substances, when present, may indicate, first of all, very slight disturbances, but they may be of special value in judging whether a disorder of the nutrition in the breast-fed infant has completely cleared up. Of special interest is the fact that an insufficient amount of food does not lead to marked increase of the phosphates in the

[1] For this test, see standard text-book on Urinalysis.

urine. This may serve to distinguish readily such cases of slight inanition which were mentioned above.

Artificial Feeding.—The study of artificial feeding of the infant is still empirical to a great extent. It is beset by many difficulties, due to the fact that, under normal conditions, the infant like the adult possesses a wide tolerance with regard to the amount and composition of its food. Thus a diet may be borne for some time without giving rise to any visible ill-effect, but, if continued, it may prove unsuitable and harmful. Naturally, the latitude of tolerance is of great benefit to the infant. Thus we understand readily why so widely different mixtures can be fed successfully. When called upon to regulate the diet of a given infant, it is not possible to test the latitude of its tolerance, so we must decide upon some method, which experi-

Fig. 857.—Proper method of holding the nursing bottle. (*Brophy.*)

ence has taught promises results in a majority of cases. Another desirable feature of any method of feeding is simplicity.

The good results obtained on the breast have been used as the starting point for artificial feeding. Soon it became evident that cow's milk, by far the most important substitute for human milk, differed in its composition from the latter. This is not the place to enter into a detailed discussion of these differences. Neither can we allot any space to a discussion of the variations of the cow's milk derived from different breeds, nor to the variations in the composition of the milk of a single animal. It suffices to point out that milk, serving as food for an infant, should be mixed milk from a large number of animals, excluding breeds whose milk is known to contain a special high fat content. It is preferable to obtain the milk from Holstein Friesian cows. The herd should be under the supervision of a competent veterinarian and tuberculin tested. The production and shipping should be under competent

control, thus insuring the necessary cleanliness in obtaining and handling the milk. It should be cooled immediately, shipped and delivered cool. The proper handling after its delivery is as important. The milk should be kept on ice and thoroughly protected until it is prepared for use. When the desired milk mixture is prepared, it is put into nursing bottles, which are placed in a vessel containing cool water. The water is brought to boiling and kept there for about five minutes, whereupon the bottles are cooled as rapidly as possible and put on ice until used.

Composition of Milk.—The main differences between human and cow's milk are these:

FIG. 858.—Improper method of holding the nursing bottle. The bones of a young infant are easily molded so the nipple pushes the hard palate upward and presses the alveolar processes forward. This causes the maxillæ to protrude, thus producing a marked deformity in certain cases. The alveolar processes of the mandible are also pushed backward. Sucking of the thumb and the use of the pacifier will cause the same deformity in many instances. (*Brophy.*)

	Protein, per cent.	Fat, per cent.	Sugar, per cent.	Ash, per cent.	Total solids, per cent.
Human milk......	1.5	4	6–7	0.2	12
Cow's milk.......	3.5–4	3.5–4	4.5	0.75	12

The proteins of cow's and human milk show a further difference. Human milk contains about as much, or more, protein other than caseinogen, while in cow's milk the caseinogen exceeds these proteins considerably. The fat of human milk contains less volatile fatty acids and more unsaturated fatty acids. With these differences it was but natural that efforts were made to modify cow's milk to resemble human milk in order to obtain good results. Here we may point out a very striking fact. In nearly all methods of modifying cow's milk, the first mixtures given contain a relatively low percentage

of protein, approaching the protein content of human milk. With advancing age of the infant, the proteins are increased. In this we have a striking contradiction to the breast-milk whose protein content during lactation changes very little and in the opposite direction. This fact seems to demonstrate very clearly that the nature of the two kinds of food, as known thus far, is not such that the one need serve as an absolute guide in the preparation of the other.

Formulæ.—The beginning of the artificial feeding is the most difficult part. During the first week the infant, as a rule, receives relatively little food. The milk is diluted with two equal parts of water or barley water, to which solution may be added some carbohydrate. In the following table a rough sketch of the feeding is given:

Age	No. and amount of single meals	Total amount	Proportions	Carbohydrate
1 wk	6 × 20—60 cc.	120–360 cc.	1 milk 2 barley water	2–10 grams
2–4 wks.............	5 × 100—150	500–750	1 milk 2 barley water	20
5 wks.–2 mos........	5 × 150—170	750–850	1 milk 1 barley water	30–40
3 mos...............	5 × 180	900	1 milk 1 barley water	30–40
4–6 mos.............	5 × 180—200	900–1000	2 milk 1 flour	30–40
7–9 mos.............	5 × 200	1000	2 milk 1 flour	40–50

We have confined ourselves to giving a very rough table, and even this is done with a certain degree of reluctance. First of all, it is always hazardous to raise an infant on a table where only the age is taken into consideration. Then there are many infants thriving well on the same milk mixture for a prolonged period, and a change should only be made when indicated by the needs of the infant. As Czerny and Keller state, those acquainted with the signs of over- or under-feeding do not need any tables, while those not acquainted with these signs do not derive much good from them. A very simple way to determine approximately the daily total amount of food for a baby is this: During the first quarter, the baby takes about 1/5 to 1/6 of its body weight; during the second about 1/7, and later on about 1/8 to 1/9. It is started on a mixture containing one part of milk to two parts of barley water, reaching whole milk about the eighth or the ninth month. The changes are thus made according to the demands.

Carbohydrate Content.—Carbohydrate is added according to its deficiency in the milk used. For instance, an 800 cc. mixture is given of half milk and half barley water. Four hundred cc. milk contain 18 gm. carbohydrate.

The total amount should contain 56 gm., so we have to add about 38 gm. Besides, it has been found that many babies thrive better when, in addition to the sugar, some flour is added to the milk. This may be given in the form of wheat, barley or oatmeal flour. During the first month 5 gm. of flour are added to each liter of milk mixture; in the second 10 to 20 gm., in the third 15 to 30 gm., and in the second quarter 30 to 40 gm. The flour is stirred with luke-warm water and boiled ten to twenty minutes. As long as the infant is well, milk sugar can be used for the carbohydrate addition. If any disturbances arise, it is better to add dextri-maltose or cane sugar. If we wish to calculate the amount of food on the basis of the energy requirement, we remember that the normal breast-fed infant needs about 100 calories per kg. body weight during the first quarter year; 90 in the second; 80 in the third; and 70 in the fourth. One gram of protein yields about 4 calories; 1 gm. of carbohydrate 4 calories; and 1 gm. of fat about 9 calories. The artificially fed infant may require a food somewhat higher in caloric value.

Fortunately, the latitude of tolerance, as pointed out above, permits of rather wide variations in the amount and composition of the food. Nevertheless, in artificially fed cases it is well to watch for signs of excess with even greater care than in the breast-fed baby, and we cannot emphasize too strongly the necessity of expert advice as soon as the infants do not do well; in fact, all artificially fed infants should be under constant, competent supervision. Furthermore, it is a very good rule to begin with a relatively scanty diet, increasing it with careful observation of the results.

Here we have to limit ourselves to a very brief discussion of a few points concerning the composition of the food. For some of the methods which are in vogue, particularly in this country, we refer the reader to the current text-books on Pediatrics. We refrain intentionally from outlining the methods in which simple milk dilutions are enriched by the addition of fat in the form of cream, since, according to Finkelstein, the addition of the carbohydrates insures success in a larger number of cases.

Alkalis.—Many authors recommend the addition of alkali because, in human milk, the relation of alkali to acid is greater than in cow's milk. Commonly, lime water is added, which, when freshly prepared, corresponds to a 1/20 alkali solution. During the first few months, five per cent. is added, *i.e.*, 5 cc. to each 100 cc. Others recommend the addition of sodium bicarbonate. Another factor is the inhibiting influence of alkalis on the rennet reaction, which tends to prevent the formation of large, tough curds in the stomach. This can be accomplished more readily by decalcifying agents or, rather, agents rendering the calcium of the milk unavailable for the rennet reaction. Sodium citrate (two per cent.) is used for this purpose most frequently. It seems that the infant is thus capable of assimilating more concentrated milk mixtures, particularly in early life. There are some theoretical reasons why the addition of alkali to the milk may be of benefit, classifying sodium citrate among the alkalis. The ash of human, as well as cow's

milk, is alkaline. The ash of one gram of milk corresponds to the alkalinity of about 0.15 cc. one-tenth normal sodium hydroxide solution (Kastle). The alkalinity of the ash is called the available alkalinity of the milk because, assuming that the infant burns its food as in ashing, a certain amount of alkali is available for the economy of the organism. Sodium citrate contains sodium in such amounts that 1 gm. of the salt yields enough sodium to make about 84.5 cc. one-tenth normal sodium hydroxide solution. Should the citric acid of the molecule be burned in the organism (and, indeed, the urine may readily become alkaline), we see that a considerable amount of sodium remains at its disposal. The addition of 0.2 per cent. sodium citrate to whole milk would a little more than double the available alkalinity of this milk, and it is not improbable that it is due to this increased available alkalinity that the infant may take care of greater milk concentrations. It may be mentioned that orange juice yields an alkaline ash, while the ash of oatmeal is acid.

Stools.—The result of the feeding is judged by the same token as in the breast-fed infant. With regard to the stools there is this exception: the stools are alkaline in reaction, with a preponderance of gram negative bacteria, belonging to the colon group. The reaction and the bacteria may be influenced by the diet. For instance, on feeding a mixture relatively poor in protein and fat, but rich in carbohydrates, the stools become acid and the gram positive micro-organisms prevail, as in the breast-fed infant. The possibility of influencing the stools and general condition by the diet, in lighter cases of nutritional disturbance, is of great therapeutic value. Green, loose, foul-smelling passages may be corrected by reducing the protein and adding carbohydrates. Here it becomes necessary to call attention to a very significant fact. When we change the amount of one of the ingredients, we not only change it, but we alter the relationship of this ingredient to the others. Suppose we have a mixture containing two per cent. protein, two per cent. fat and six per cent. carbohydrate, and change to one per cent. protein. The previous relationship of 1:1:3 is changed to 1:2:6, that is, the balance of the food ration is altered considerably. *This balance is of great importance.* Another very important feature is the relationship of the mineral constituents of the food to each other and to the other ingredients of the food. In practice we have been accustomed to speak of an increase or decrease in protein, fat or carbohydrate, but we should not lose sight of the other radical changes we introduce. To return to the influence of the diet on the stools. If the stools are loose, acid and perhaps, foamy, they may be corrected by increasing the proteid and reducing the carbohydrates.

Nutritional Disorders.—When meeting with difficulties in raising the infant on artificial feeding, the management of its nutrition should be entrusted to a physician well acquainted with the various disorders of nutrition. We will give a brief outline of the most satisfactory classification of the disorders of nutrition at our disposal, the one given by Finkelstein. The dis-

orders of the nutrition are characterized by the fact that manifestations of disease are due to the abnormal course of the processes of nutrition and that no other factors, as, for instance, infection from the outside, enter into consideration. The food, therefore, is the one injurious agent. Finkelstein classifies the disorders of nutrition thus:

1. State of disturbed balance.
2. State of dyspepsia.
3. State of decomposition.
4. State of intoxication.

In all cases of disorders of nutrition, a careful history is very important.

1. *State of Disturbed Balance.*—Here, in spite of a diet suitable in its composition and sufficient in caloric value, the gain in weight does not proceed normally. The weight curve shows ups and downs, while *in toto* some gain may be registered or the weight may remain stationary for a long time. Other signs of disturbed health are not wanting. A previously healthy infant may enter the state of disturbed balance, a state where its reaction to food is abnormal, for various reasons. An unsuitable diet or infection may lead to it. It must be understood that the infection only changes the reactivity of the infant to food. A change of the reactivity is overcome by choosing a food which can be assimilated easily. In another group of cases, the diet has been one suitable for normal babies and there is no history of any previous injury, so we have to consider them as of low tolerance congenitally.

A diet may be unsuitable either by introducing too large amounts of otherwise suitable milk mixtures or giving mixtures, which are deficient in one or more ingredients, for too long a time. This may happen easily when some therapeutic food is used. The most frequent and best known disorder entering into consideration here is the injury of the nutrition due to milk, the so-called "Milchnähr schaden" (Czerny and Keller). On a diet apparently well tolerated, the baby's weight becomes stationary, the sleep disturbed, while during waking hours the baby is restless. The mucous membranes and skin become pale. The tonicity of the muscles is reduced and the abdomen is distended. The stools are dry and white, the so-called "soap stool." Besides, there may be itching eczemas and the urine may acquire an ammoniacal odor. If the diet is changed now, there may be a prompt improvement. It has been found that the fat of the food has to be diminished and the carbohydrates increased when the disorder has lasted for some time. In very mild cases, skimmed milk, in different dilutions, may be all that is necessary. Later on, quicker results are obtained by means of Keller's malt-soup. In other cases, buttermilk, with addition of sugar, has been used with success. Under treatment, the stools become softer while the general clinical picture shows a decided improvement and the weight curve begins to move upward. Human milk has proved of great benefit in this condition, even though it has a high fat content. The younger the infant, the more

advisable it is to give human milk. On human milk, the bowels may first become worse (*i.e.*, loose, green, slimy and more frequent for a few days) and the weight drop. After about four days a marked improvement begins, which, later on, can be accelerated by substituting one meal of human milk by one of a mixture poor in fat and rich in ash, like buttermilk. It cannot be emphasized too strongly that the food mixtures used here for therapeutic purposes should not be continued for too long a time. In the disorders of nutrition there occurs a period of reparation, that is, the time during which the infant is in need of a therapeutic food, but it cannot be regarded as cured until it can tolerate a milk mixture suitable for its age and weight. When this time has arrived, the continuance of the therapeutic food may lead to renewed disturbances. Under certain conditions, the baby may do well on condensed milk after having had trouble on other milk mixtures, particularly such rich in fat, but if the condensed milk is continued too long, it may lose weight again, get diarrhea, etc. This period of reparation does not only occur in the state of disturbed balance, but in other groups as well.

2. *State of Dyspepsia.*—This group is characterized by an acute disturbance of the gastro-intestinal tract with more or less diarrhea. The weight may drop somewhat or remain stationary, and the temperature rarely exceeds subfebrile values. The most important therapeutic procedure is the reduction of the food to the sustaining diet. A more detailed presentation of this very comprehensive group would lead us entirely too far.

3. *State of Decomposition.*—This represents a very severe disorder of the nutrition, in which the introduction of otherwise suitable food leads to a severe alteration of the general condition associated with a pronounced drop in weight. In severe cases even food much below the sustaining diet may lead to severe reactions and collapse. Decomposition is a sequence of the dyspeptic state where the proper therapeutic measures have not been taken or have been of no avail. An infant in the pronounced state of decomposition is very much emaciated and the skin shows a peculiar pale, grayish color. The sensorium is normal. There is a state of abnormal excitation, the infant always being restless and sleeping little. The respiration shows some deviation from the normal. The pulse is small and slow. There is a tendency to subnormal temperature, which is one of the early and significant symptoms of decomposition. It is remarkable that the appetite is rarely diminished; on the contrary, it may be increased considerably. Frequently both fists are put in the mouth and sucked. The stools are rarely of normal appearance as long as the food of a usual proper caloric value is given. Their character depends on the character of the food. On reduced feeding, the stools may appear normal and need not be increased in number. Often there is vomiting. To this group of decomposition belong the cases formerly called atrophy where the atrophic state is not due to foreign causes, as, for instance, tuberculosis.

The so-called "Eiweissmilch" of Finkelstein and Meyer is frequently used

in the treatment of this condition. It is prepared as follows: One liter of milk is coagulated by means of rennet and the whey is allowed to drain off. The coagulum is taken up in half a liter of water and passed through a fine sieve under gentle pressure. It is then added to one-half liter of buttermilk. The mixture is boiled after the addition of about 10 gm. of flour. In the beginning, about 20 gms. of dextri-maltose are added, later more. At first about 200 cc. are given in twenty-four hours, either without discontinuing the food or after a water diet of about twelve hours. When the stools have improved, the amount is quickly increased to 150 or 200 cc. per kg. of body weight.

4. *State of Intoxication.*—This is characterized by severe diarrhea, a sudden marked drop in weight and other symptoms showing a profound alteration of all the functions of the body. Here we have the collapse and nervous symptoms. The face is mask-like, without the play of the facial muscles for minutes at a time. The eyes remain fixed, the sensorium is affected, the movements of the extremities are slow and they remain in the same position for a long time. There may be chewing motions and other more or less stereotype movements. The temperature is increased and may reach hyperpyretic values. The respirations are slow and deep. The diarrhea may be extremely severe. The pulse is increased and, often, very small. The heart sounds are dull. The number of leucocytes is increased. The urine contains albumin, casts and sugar, the excretion of the latter being purely alimentary. Severe vomiting may occur. The nervous symptoms are usually very pronounced, with strabismus, turning up of the eye-balls and convulsions.

Intoxication may develop either from a state of dyspepsia or of decomposition. In the latter, the prognosis is worse. In spite of its severity, the intoxication may yield rapidly to a proper treatment, which consists of a water diet from twenty-four to forty-eight hours. On resuming the feeding, it is better to start with small amounts of human milk (first flow from breast), giving at first 50 cc. in twenty-four hours. Artificial food is also given in very small amounts at the start.

It must be distinctly understood that we have restricted ourselves to the merest sketch of the question under discussion. It has been our aim to point out the right direction, rather than to furnish an array of formulas and tables which can never replace the study and experience necessary to those who want to give the infant a chance for life.

CHAPTER XLII

LIGATURE OF ARTERIES

COMMON CAROTID ARTERY

Anatomy.—It is essential that the anatomy of the part be thoroughly understood before attempting to ligate an artery. One should never do this work without previous preparation. The best method of studying the loca-

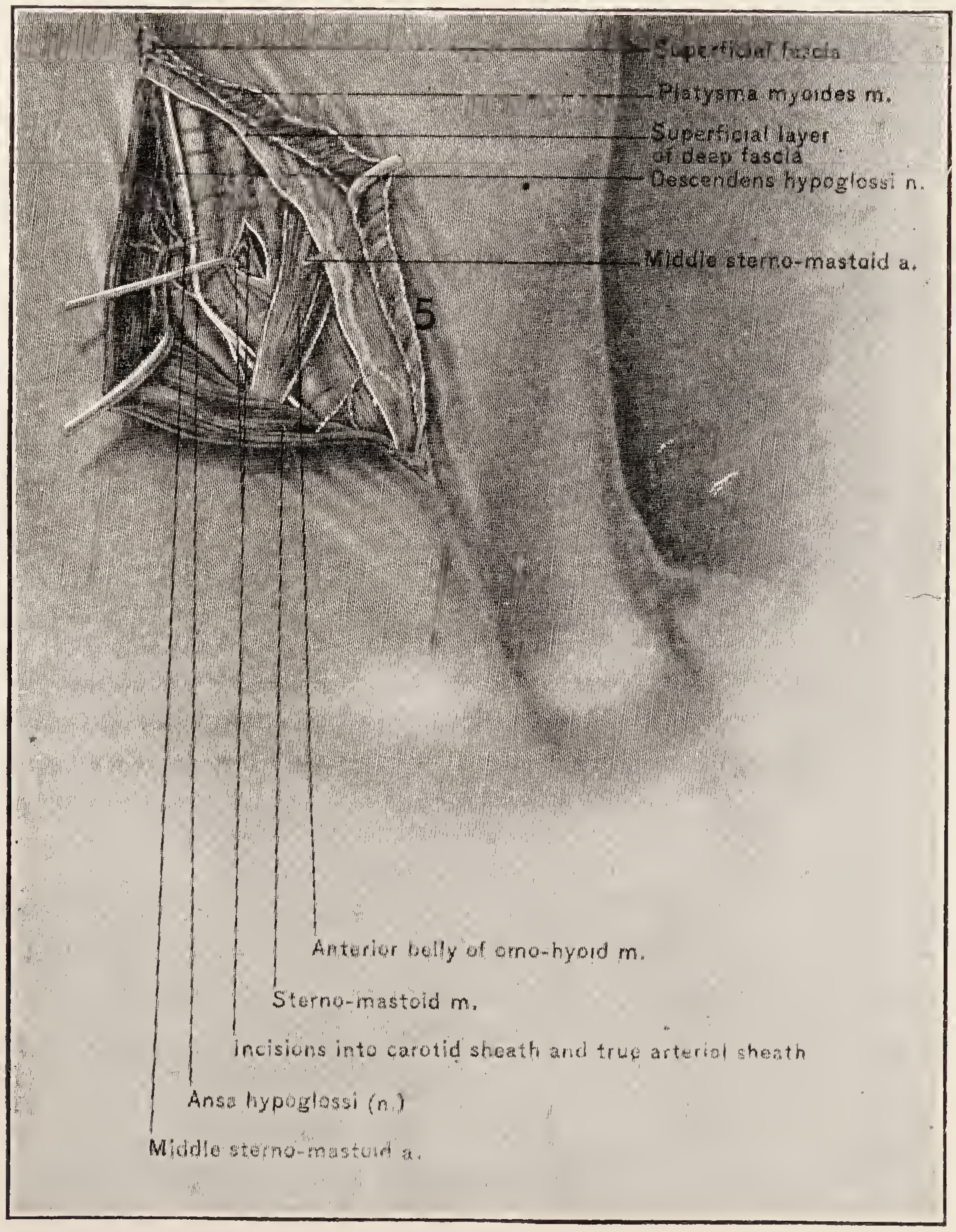


FIG. 859.—Exposure of common carotid artery in superior carotid triangle. (*Deaver.*)

tion of the various arteries is to dissect them on the cadaver and note the relations carefully. The anatomy of the arteries is well described by F. R. Sabin in Morris' Anatomy. This work has been followed and freely quoted

in the succeeding pages. As the common carotid artery is best ligated at the level of the cricoid cartilage, the anatomy of this point is here detailed (Fig. 859). In front the artery is covered by skin, superficial fascia, platysma myoides muscle and the deep fascia. It is more or less overlapped by the sterno-mastoid muscle. Opposite the cricoid cartilage it is crossed obliquely by the omo-hyoid muscle, and above this spot by the middle and superior thyroid, the lingual and, generally, the anterior facial veins in their course to the internal jugular, and by the sterno-mastoid artery as it passes from the superior thyroid artery, its usual source, on its way down to the sterno-mastoid muscle. Along the anterior border of the sterno-mastoid, there is a communicating vein between the facial and anterior jugular veins, which, as it crosses the line of the carotid artery, is in danger of being wounded in the operation of tying the the common carotid artery. Posterior to the artery, but in the same sheath, is the vagus nerve, and posterior to the sheath, the chain of the sympathetic and the cervical cardiac branches of the sympathetic and vagus nerves are found. At the lower part of the neck, the inferior thyroid artery crosses obliquely behind the carotid artery, as does likewise the recurrent laryngeal nerve. Internal to the artery is found the esophagus and trachea, with the recurrent laryngeal nerve between them. The terminal branches of the inferior thyroid artery, the lateral lobe of the thyroid body, the cricoid and thyroid cartilages and the lower part of the pharynx are also seen internal to the common carotid artery. External to the artery is found the internal jugular vein and vagus nerve. On the right side, at the root of the neck, the vein diverges somewhat from the artery, leaving a space in which the vagus nerve and vertebral artery are exposed. On the left side the vein approaches and somewhat overlaps the artery, thus leaving no interval corresponding to that on the right side.

Incision.—The line of incision (Fig. 860) runs transversely at the level of the cricoid cartilage, its center being at the anterior border of the sterno-mastoid muscle. After dividing the skin and platysma muscle, the transverse superficial cervical nerve is seen running over the sterno-mastoid muscle. This should be avoided. The muscular fibers of the sterno-mastoid are exposed and the anterior border pulled outward with a hook. Beneath is found the omo-hyoid muscle and the artery is situated in the angle formed by this and the sterno-mastoid muscle. Fascia, which is a part of the vessel sheath, covers the common carotid and this should be opened. The descendens hypoglossi nerve is located on the sheath and should be avoided and drawn inward. The vagus nerve lies close to the posterior surface of the artery and should not be included in the ligature. The internal jugular vein and the corresponding sympathetic nerve are also to be avoided. After exposing the artery thoroughly, a double catgut ligature is passed by means of an aneurism needle and one portion of it is first tied, followed by the tying of the second. After the second ligature is thoroughly tied, the first may be tightened and then both are tied together. If the vessel is affected with arteriosclerosis,

great care should be taken to ligate it in the portion least involved. If the artery is to be occluded temporarily, a rubber covered clamp is usually sufficient. This clamp does not injure the arterial walls to any great extent.

Dangers.—There is considerable risk associated with the ligature of the common carotid artery. A great portion of the head receives its blood supply through this artery and to shut this off suddenly is obviously attended with considerable danger to the individual. One should be extremely careful to determine that it is essential to ligate this artery and that ligation of the internal or external branch will not be sufficient to arrest or control hemorrhage in some contemplated operation. The patients, who die as a result of ligature of this artery, usually die not as a result of sepsis, but because of the marked cerebral disturbance set up by the anemia. In selected cases the collateral

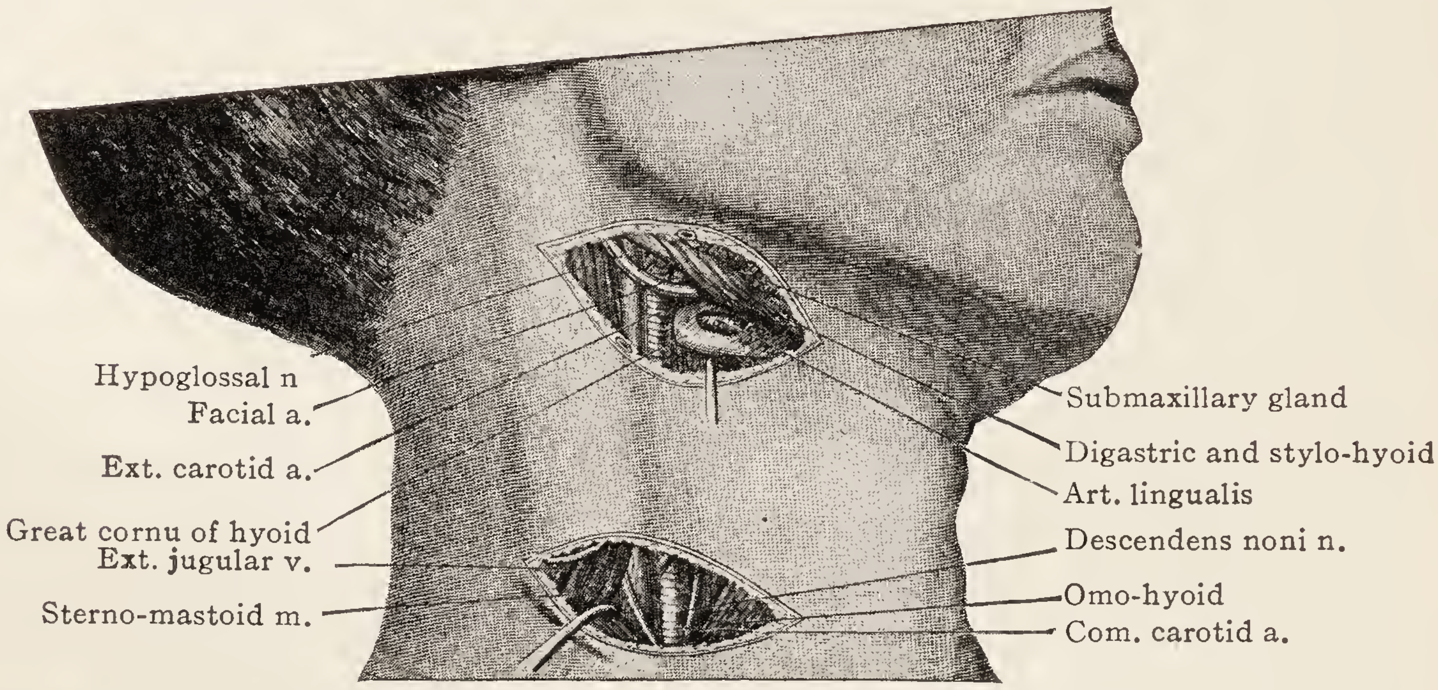


FIG. 860.—Ligature of the lingual artery above the greater cornu of the hyoid. Ligature of the common carotid at the level of the cricoid cartilage. (*Kocher.*)

circulation may be sufficient to counteract this anemia, but one should avoid ligating the artery in those who are at all arteriosclerotic. Temporary ligature of the artery is not so dangerous. Frequently it is of marked benefit, especially when it is difficult to determine exactly where the hemorrhage originates. A broad band may thus be used and the artery compressed until the circulation is stopped for a few hours. The band is then released and usually the hemorrhage will be under control.

Collateral Circulation.—The collateral circulation is carried on chiefly by the anastomosis of the internal carotid artery with its fellow on the opposite side through the circle of Willis; by the vertebral with the opposite vertebral; by the inferior thyroid with the superior thyroid; by the deep cervical branch of the costo-cervical trunk with the descending branch of the occipital; by the superior thyroid, lingual, facial, occipital and temporal with the corresponding arteries on the opposite side, and by the ophthalmic with the angular. The anastomosis between the deep cervical branch of the costo-

cervical trunk with the descending branch of the occipital is an important one. It is situated deeply at the back of the neck and is to be found lying between the semi-spinalis capitis and cervicis muscles.

EXTERNAL CAROTID ARTERY

Anatomy.—In front of the external carotid artery, in addition to the skin, superficial fascia, platysma and deep fascia, are found the hypoglossal nerve, the lingual and common facial veins, the posterior belly of the digastric and stylo-hyoid muscles, the posterior facial vein, the superior cervical lymphatic glands, branches of the facial nerve and the parotid gland. Behind, the external carotid is in relation with the internal carotid, from which it is separated by the stylo-glossus and stylo-pharyngeus muscles, the glosso-pharyngeal nerve, the pharyngeal branch of the vagus nerve, the stylo-hyoid ligament and the parotid gland. The superior laryngeal nerve crosses behind the external and internal carotid arteries. The hyoid bone, the pharyngeal wall, the ramus of the jaw, the stylo-mandibular ligament, which separates

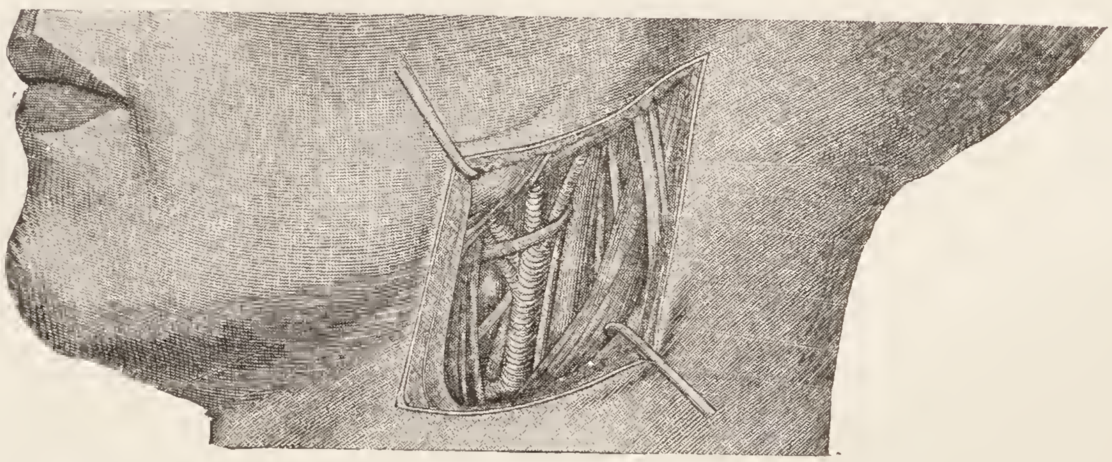


FIG. 861.—Ligature of the external carotid with the origins of the lingual, facial and occipital arteries. (*Kocher.*)

it from the submaxillary gland, and the parotid gland are found. Externally, the carotid artery is in contact with the internal carotid artery in the first part of its course.

Incision.—The external carotid artery is ligated for several conditions beside hemorrhage. If malignant growths are attached to it, it is best to ligate the artery and remove it with the growth. In performing extensive operations on the jaws it is advisable to ligate the artery because thus the hemorrhage is controlled. It also controls the hemorrhage resulting from extensive operations on the nose and naso-pharynx.

The usual incision is made in an oblique direction along the anterior border of the sterno-mastoid muscle, directly over the artery, which may be felt pulsating beneath the skin (Fig. 861). The center of the incision usually lies a finger's breadth below the angle of the mandible. The external jugular vein and the great auricular nerve should be avoided as they pass upward on the sterno-mastoid muscle. The facial vein is exposed as soon as the cervical

fascia is divided; this should be retracted. When the cervical fascia is drawn to either side, the external and internal carotid arteries are exposed. The latter is posterior to the former and it gives off no branches, while the external carotid sends a branch to the thyroid and several branches further up. This is not an easy operation as the muscles frequently vary in their course. The descendens hypoglossi and the superior laryngeal nerves should be avoided carefully. A double ligature is passed around the artery and tied in a manner similar to that mentioned under the carotid.

Dangers.—This operation is not an easy one as we have no accurate guide in determining the location of the external carotid artery. As is well known, the soft parts vary considerably in different individuals and, therefore, the operation is attended by the danger of severing nerves in this location. It is excellent practice to start the dissection at the lower border of the digastric muscle. Great care should be exercised in avoiding the superior laryngeal nerve and also one should be sure that the external carotid artery is secured and not the internal. As far as the life of the patient is concerned, there is no more danger than is present in any operation.

LINGUAL ARTERY

Anatomy.—The lingual artery (Fig. 96) arises from the front of the external carotid, between the superior thyroid and the facial arteries, often as a common trunk with the latter vessel, and nearly opposite or a little below the greater cornu of the hyoid bone. It may, for purposes of description, be divided into three portions: The first, or oblique, extends from its origin to the outer edge of the hyoglossus muscle; the second, or horizontal, lies beneath the hyoglossus; the third, or ascending, beneath the tongue. The oblique portion is situated in the superior carotid triangle and is superficial, being covered merely by the integument, platysma and deep fascia. Here it lies upon the middle constrictor muscle and superior laryngeal nerve. After ascending the short distance, it curves downward and forward beneath the hypoglossal nerve and, in the second part of its course, runs horizontally along the upper border of the hyoid bone, beneath the hyoglossus, by which it is separated from the hypoglossal nerve, the posterior belly of the digastric, the stylo-hyoid muscle and the lingual vein. In this part of its course, it lies successively on the middle constrictor of the pharynx and the genioglossus muscle and crosses a small triangular space known as "Lesser's triangle," the sides of which are formed by the tendons of the digastric, the base by the hypoglossal nerve and the floor by the hyoglossus muscle, in which situation it is usually tied. In the third part of its course, it ascends tortuously, usually beneath the anterior margin of the hyoglossus, to the under surface of the tongue, and is thence continued to the tip of that structure lying between the lingualis and the genioglossus muscles. From the anterior edge of the hyoglossus to its termination, it is only covered by the mucous membrane of the under surface of the tongue.

Incision.—Owing to the fact that, many times, hemorrhage from the tongue is controlled with difficulty by pressure or ligating the small vessels which are located in its substance, it is advisable to ligate the lingual artery nearer its source. When the tongue is to be operated for carcinoma and other tumors, it is best to ligate the artery as a prophylactic measure. The location of this artery is usually very definite and the great cornu of the hyoid bone is an excellent guide for localizing it.

The incision is made as follows: The skin and platysma are divided as directed under the external carotid artery, but the fascia is incised over the great cornu of the hyoid bone, being careful to avoid the facial vein as it passes vertically downward. The hyoglossus muscle is exposed and the muscular fibers divided. The lingual artery is found beneath this muscle. A ligature is then passed and tied.

Dangers.—The dangers in performing this operation are few. However, one should be careful not to sever the hypoglossal nerve, the digastric or stylo-hyoid muscles or the facial and external carotid arteries. The danger to life is nil.

FACIAL ARTERY

Anatomy.—The facial artery (Fig. 862) arises immediately above the lingual from the fore part of the external carotid, at times as a common trunk with the lingual. Its course is forward and upward, in a tortuous manner, to the mandible and, passing over the body of this bone at the anterior edge of the masseter muscle, winds obliquely upward and forward over the face to the inner canthus of the eye where it anastomoses under the name of the angular artery with the nasal branch of the opthalmic. For convenience of description, the artery is divided into a cervical and a facial portion. As it is ligated in the cervical portion, a description of the remainder of the artery is not given. The cervical portion ascends tortuously from its origin upwards and forwards beneath the posterior belly of the digastric and stylo-hyoid muscles, and usually, also, beneath the hypoglossal nerve and then, making a turn, runs horizontally forwards for a short way beneath the mandible, either imbedded in or lying under the submaxillary gland. It has here the mylo-hyoid and stylo-glossus beneath it. On leaving the cover of the gland, it forms a loop, first passing downwards and then upwards over the lower border of the mandible immediately in front of the masseter muscle, where it is superficial, being covered merely by the integument and platysma. Here it can be felt beating and can be compressed readily. The vein is separated from the artery by the submaxillary gland, the posterior belly of the digastric, the stylo-hyoid muscle and the hypoglossal nerve.

Incision.—The incision (Fig. 863) usually is made at the angle of the mandible, as follows:

The anterior border of the masseter muscle is located and the skin divided parallel to the margin of the mandible opposite this muscle. The facial artery lies very superficial and, therefore, is found easily. It is separated

from its surrounding structures, avoiding the facial nerve which runs along the margin of the mandible.

Dangers.—There is little danger connected with this operation, but one should be careful to avoid the supramaxillary branch of the facial nerve, which lies nearly parallel to the artery at this point.

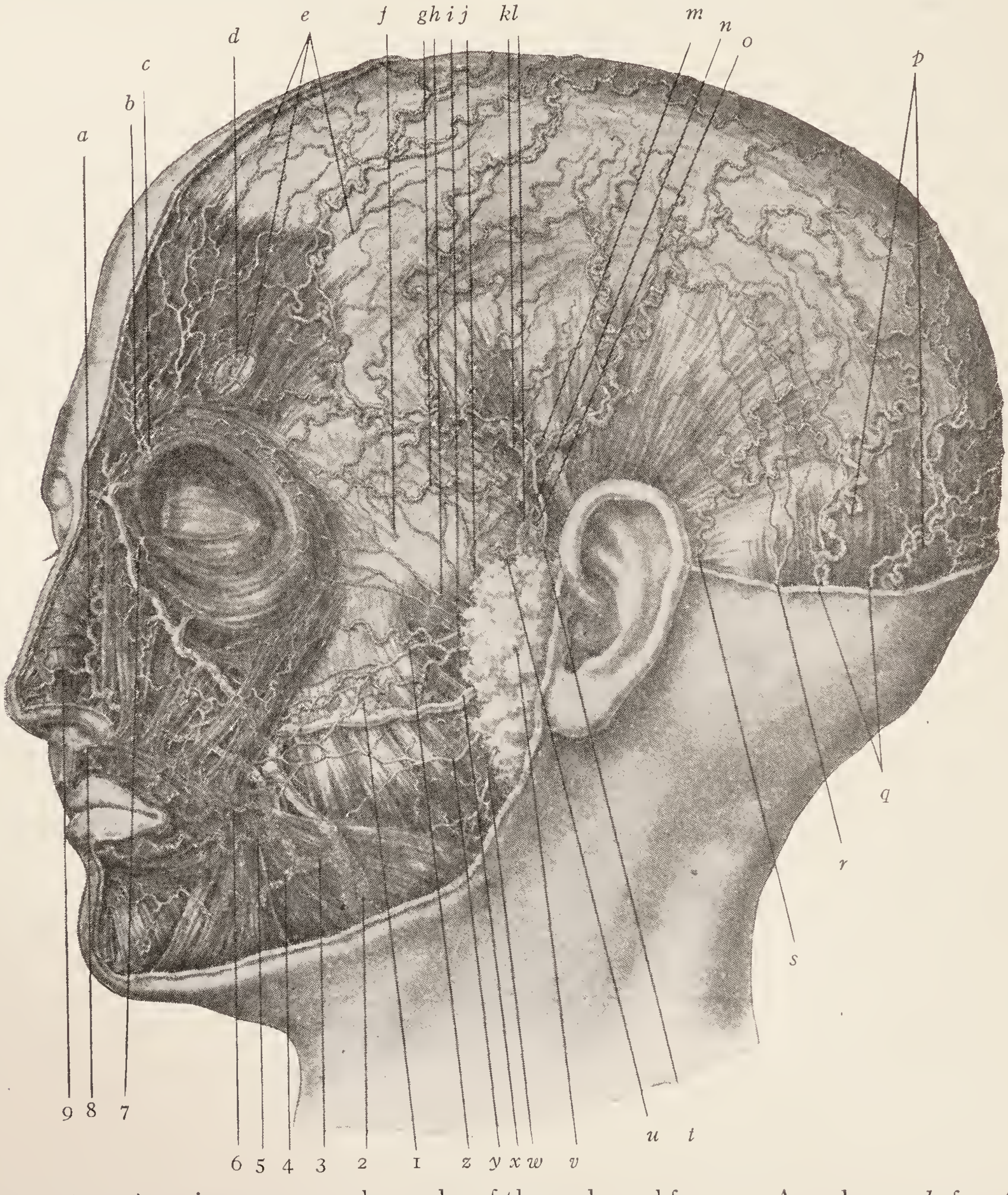


Fig. 862.—Arteries, nerves and muscles of the scalp and face. *a*, Angular a.; *b*, frontal a.; *c*, supratrochlear n.; *d*, supraorbital a.; *e*, supraorbital n.; *f*, temporal br. of orbital n.; *g*, orbital a.; *h*, malar br. of facial n.; *i*, transverse facial a.; *j*, temporal br. of facial n.; *k*, anterior temporal a.; *l*, superficial temporal a.; *m*, posterior temporal a.; *n*, auriculo-temporal n.; *o*, superficial temporal v.; *p*, occipital a.; *q*, great occipital n.; *r*, small occipital n.; *s*, posterior auricular a.; *t*, anterior auricular a.; *u*, middle temporal a.; *v*, parotid gland; *w*, supramaxillary br. of facial n.; *x*. Stenson's duct; *y*, buccal br. of facial n.; *z*, infraorbital br. of facial n.; 1, socia parotidis; 2, facial v.; 3, facial a.; 4, inferior labial a.; 5, inferior coronary a.; 6, superior coronary a.; 7, infratrochlear n.; 8, artery of septum; 9, lateral nasal a. (*Deaver.*)

TEMPORAL ARTERY

Anatomy.—The temporal artery (Fig. 862) arises opposite the neck of the mandible and, under cover of the parotid gland, passes upward in the

interval between the condyle and external auditory meatus to the zygoma, lying on the capsule of the joint. Thence it ascends over the posterior root of that process and the temporal aponeurosis for about 4 or 5 cm., and there is divided into an anterior and posterior branch. It is surrounded by a dense plexus of sympathetic nerves and is accompanied by the auriculo-temporal nerve, which lies beneath and generally a little behind it. It is crossed by the temporo-facial division of the facial nerve and by the auricularis anterior muscle. As it crosses the zygoma, it can be felt pulsating immediately in front of the ear, and in this situation can be compressed against the bone. Here it is quite superficial, being covered by the integument and a delicate prolongation of the cervical fascia.

Incision.—To ligate this vessel, the following incision is made:

The skin is divided vertically over the zygoma at the point where the superficial temporal artery can be felt pulsating. The incision is about 1 cm. in

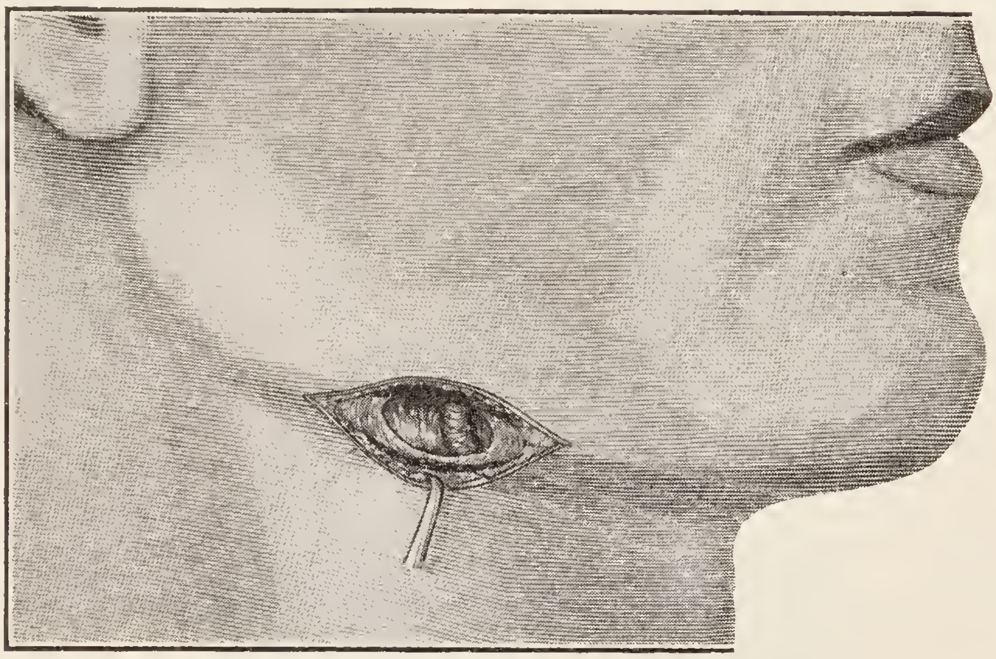


Fig. 863.—(*After Kocher.*)

length and its center is just in front of the anterior end of the helix. The artery is found under the superficial layer of the aponeurosis. The temporal vein should be avoided.

Dangers.—The dangers attendant upon this operation are practically nil. However, one should be careful to avoid the temporo-facial division of the facial nerve and the auriculo-temporal nerve.

CORONARY ARTERY

Anatomy.—The inferior coronary artery (Fig. 862) arises at the angle of the mouth and runs in the under lip within the substance of the orbicularis oris, close to the mucous membrane. It anastomoses with the artery on the opposite side. Frequently an additional branch passes from the external maxillary to the lower lip. The superior coronary artery, rising from the facial a little higher than the inferior, passes forward beneath the zygomaticus and then, like the inferior coronary, courses tortuously along the lower margin

of the upper lip between the orbicularis oris and the mucous membrane, about 1/2 cm. from the junction of the mucous membrane and the skin. It is larger, usually, than the inferior coronary artery. It anastomoses with its fellow of the opposite side and gives off a small artery to the nasal septum. Compression of this vessel sometimes will control hemorrhage from the nose.

Incision.—These vessels may be ligated in the treatment of angioma by making an incision in the mouth. Usually, however, the ligation of coronary arteries will not be called for since in any operation which requires their division, the vessels may be seized with hemostatic forceps and the hemorrhage arrested by torsion.

CHAPTER XLIII

PROGNATHISM

Introduction.—Prognathism (Pro–before, gnasthos–jaw) is a marked projection of either jaw. Some authors use it to designate a protrusion of the teeth of the mandible beyond the teeth of the maxillæ, *i.e.*, a more or less extensive protrusion of the chin. It is also used to designate those deformities in which there is a retrusion of either jaw. In dealing with the abnormal conditions of the jaws, the various deformities may be summed up as follows:

1. Protrusion of the mandible—"bull-dog jaw."
2. Retrusion of the mandible.
3. Protrusion of the maxillæ—"parrot jaw."
4. Retrusion of the maxillæ.
5. Protrusion of both jaws.
6. Asymmetry of the face.

Fig. 864.—(*Cryer.*)

Prognathism is a condition found rather infrequently, especially the type which causes an appreciable deformity. The reason for this has been expressed by Cryer[1] as follows: "It would seem probable that the lessened prognathism of the Caucasian race is one of the principal causes of the suggested suppression of the third molar. An example of the occasional rudimentary fourth molar of the prognathous savage is seen in Fig. 864.

Protrusion of the Mandible.—Protrusion of the mandible, when extensive, is one of the most conspicuous and repulsive deformities of the face. It always places the patient at a great disadvantage and gives him the appear-

[1] Studies of the Internal Anatomy of the Face. 1901, p. 145.

ance of being pugnacious, disagreeable and uncompanionable. Even though possessing a quiet, lovable nature, he seems, so far as one can judge from his looks, to be sordid, morose and vicious.

Protrusion of the mandible, like other facial deformities, is chiefly due to inattention to the teeth during the period of eruption. The upper incisors are permitted to erupt posterior to the lower, thus favoring further and further protrusion of the mandible. The protrusion is unrestrained by the overlocking of the superior teeth and it continually increases while retrusion of the maxillæ increases or, at least, they do not develop normally. As to the cause of the dwarf development of the maxillæ, Blair says:[1] "Often protrusion of the lower jaw is accompanied by an abnormally small upper jaw. The contraction of the upper jaw is probably due to the fact that the tongue finds an abnormal amount of room within the lower dental arch, which allows the upper arch to contract or fail of full development. If the size of the lower

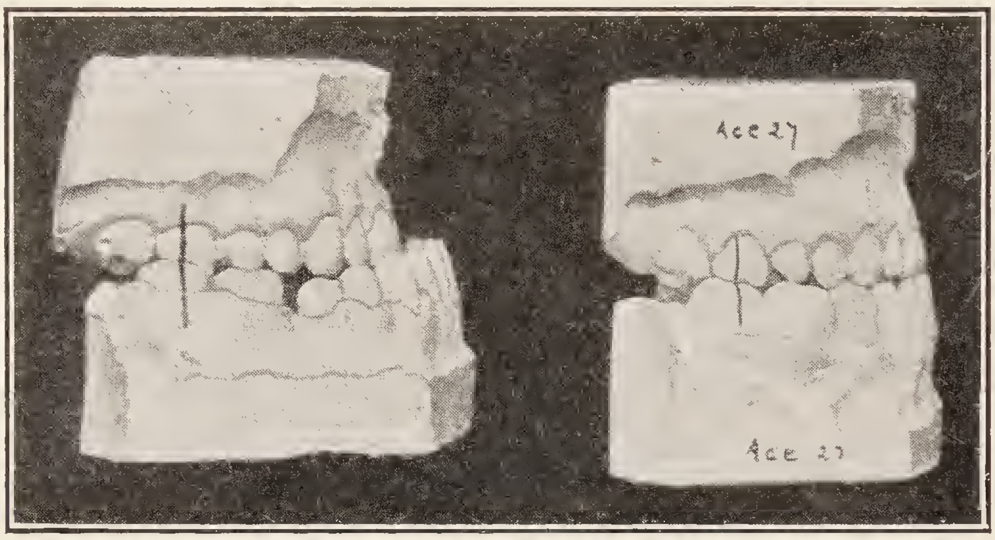


FIG. 865.—Protrusion of the lower jaw due partly to interdental spaces in the bicuspid region. Part of the protrusion is due to a sliding forward of the body as a whole, as shown by the relation of the upper and lower molars. Plaster cast of jaw after correction. (*Blair.*)

arch is suddenly contracted, the tongue will be deprived of some of its accustomed intra-oral space and must be forced back into the oral pharynx." Such conditions will not become less numerous until the laity are taught the natural laws governing physiological processes. The system of training now inaugurated in our public schools will, I believe, accomplish much in prophylaxis.

Protrusion of the mandible may be attended by recession of the maxillæ, though oftentimes this is more fancied than real. The extensive protrusion of the mandible may easily mislead one to believe that the maxillæ have receded, and though the bones may seem to have receded, often they are normal and normally placed (Fig. 865). Like many other deformities, it may be dependent on heredity. Atavism may be regarded as a potent factor.

Judging from my own observations, the cause of protrusion is to be found in a relaxation of the tendons and ligaments of the temporo-mandibular articulation. If, from any cause, the capsular ligament becomes relaxed in

[1] Blair's Text-book, page 253.

infancy, there will be a protrusion of the mandible. This protrusion is intensified by the irregularity of the teeth. Whenever the incisor and cuspid teeth of the mandible project so as to lap over the corresponding teeth of the maxillæ, *i.e.*, the teeth of the mandible pass anterior, the restraining influence

FIG. 866.—*X*-ray showing extreme anterior occlusion. (*Cryer, Dental Cosmos.*)

of the upper teeth in holding the lower ones back in place is lost. The mandible in the young is amenable to great changes in form. The bone may be bent, and this often occurs. Both angles of the jaw may become more obtuse and the chin protrude correspondingly. The mandible, therefore, continues to move forward without any resisting forces. Cryer makes use

of the following language in speaking of the factors influencing protrusion and retrusion of the jaw: "It is evident that the position of the upper jaw is more or less governed or influenced by the surrounding bones. For instance, the length of the basilar process of the occipital bone, the length of the body of the sphenoid bone and the position of the pterygoid processes may cause variation in the distance of the teeth from the center of the base of the skull, or produce protrusion or retrusion of the jaws. Another influence as to the position of the jaws lies in the greater or less degree of the height and curvature of the pharyngeal dome of the base of the skull. . . . The char-

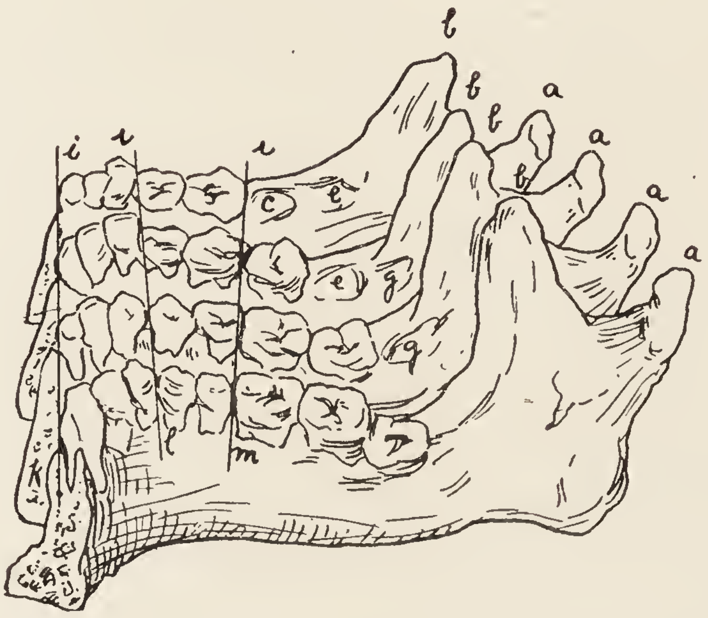


FIG. 867.—Diagram by John Hunter, illustrating the normal growth of the mandible. It will be seen that the bicuspid teeth occupy less space than did the deciduous molars which they replace. The extra space is used partly by the permanent cuspids and partly by the first permanent molar moving forward. If the teeth are not crowded into this space, bicuspid internal spaces may result. In the younger bones it will be seen that there is quite a space between the ramus and the last occluding tooth. (*Blair.*)

acter of these pharyngeal triangles or domes will influence the lateral triangle of the mandible."[1]

Signs of Protrusion of the Mandible.—In a case of protrusion of the mandible, the lower first molar tooth will usually occlude with the first upper bicuspid on either side. In very extensive protrusions, the chin may be advanced so far as to cause the first molars to occlude with the cuspid teeth above. Such a protrusion is marked by defective enunciation. It is impossible for the tongue and lips to perform their functions normally. The teeth are scarcely ever in contact except during mastication, consequently, a protrusion is attended by an accent which is typical of the defect. Biting is difficult as the incisor teeth cannot be brought in contact (Figs. 864 to 866). The profile view will often bring out the protrusion where a front view of the patient would mislead one (Fig. 841).

Retrusion of the Mandible.—Retrusion of the mandible is due primarily to the lack of development of this bone. On referring to the embryology of

[1] Op. Cit., 687.

the mandible, it is noted that there are several points of ossification. If any of these fail to fulfill their functions properly, retraction of the jaw may result. If the permanent teeth do not erupt correctly so as to spread the mandible in a forward direction, the result will be a retraction or, rather, an incomplete development of this bone. The degree of deformity in this case depends on the number of teeth which are out of alignment. The accompanying figure is a diagram by John Hunter, which shows the part played by the permanent teeth in causing the mandible to be pushed forward (Fig. 867).

Fig. 868.—Under-development of the mandible in a girl twenty-two years of age who, at the age of three, had necrosis of the lower jaw with the loss of the teeth and some bone. The only lower teeth that have erupted since are the third molars. (*Blair.*)

Diseases of the temporo-mandibular joint early in life will often cause retraction, due to interference with the normal motion. Trauma may be a factor in producing this deformity. It is more likely to result in this way if the accident occurs in infancy or chidhood (Fig. 868).

The retrusion of the mandible is a condition frequently observed in those mentally deficient. This fact has never been satisfactorily explained. Retrusion is marked by an apparent protrusion of the maxillæ which is more fancied than real. This is due to the extreme recession of the chin, the under lip often passing posterior to the upper incisor teeth.

The anterior teeth of the mandible failing to meet, the teeth of the maxillæ

continue to move upwards until they come in contact with the mucous membrane of the hard palate, into which they may become deeply embedded and extend even to the bone itself. This may lead to serious complications, such as infection, followed by necrosis of the bone, etc. The upper teeth, failing to meet the lower, extend downward, the alveolar processes move with them, and the teeth and gums are continuously exposed to view (Fig. 840).

Unless a tooth occludes with its fellow of the opposite jaw, it invariably moves gradually out of its socket and becomes elongated.

Protrusion of the Maxillæ.—Protrusion of the upper jaw is marked by an apparent or actual recession of the lower. Extensive protrusion is one of the greatest deformities with which we are acquainted. It happens in some instances that the upper teeth protrude to such an extent that the lips cover them with great difficulty. A protrusion of this character has been caused, in many cases, by improper care in feeding the infant (Figs. 857 and 858). The pose of the bottle is such that the mandible is used as a fulcrum and the bottle the lever. As the nipple passes into the mouth, pressure is made on the anterior part of the hard palate and alveolar border of the maxillæ. The child is so fed by the parent, unconscious of the deformity which may follow. The leverage forces the anterior part of the maxillæ forward while the mandible is crowded backward. The arch is therefore narrowed and elevated abnormally. In addition to the use of the bottle, the pernicious habit, which children are permitted to acquire, of sucking the thumb and pacifier leads to results equally as bad.

Retrusion of the Maxillæ.—Retrusion of the maxillæ is due chiefly to neglect of the teeth during the eruption of the permanent denture. The deciduous teeth are retained so long that the permanent incisors are diverted inward while the teeth of the mandible protrude and crowd the upper incisors still further backward, thus promoting the deformity. The mandible always acts as a wedge and, by its pressure, is a powerful factor in expanding and giving form to the maxillæ. By failure of the superior teeth to occlude anterior to the inferior teeth, the influence of the mandible in giving form to the alveolar process of the maxillæ and normal position to the teeth is lost. No factor is more potent in producing facial deformity than malocclusion of the teeth. The accompanying figures clearly convey the signs present in this deformity.

Extraction of teeth in the young is no doubt a common cause of retrusion of the maxillary bones. It may be said that it is the most frequent cause of facial asymmetry and deformities.

Protrusion of Both Jaws.—Protrusion of both jaws is attended by an extensive development of the alveolar processes forward, with the teeth protruding beyond the lips. Fig. 869 is a typical illustration of an extensive prognathism. It is taken from an article by Cryer.[1]

It shows the skull of a West African from the collection of E. T. Darby.

[1] Dental Cosmos, Vol. LV, p. 683.

To show that the prognathous condition of the jaws was due to the protrusion of the teeth, Cryer states: "If, however, this man had lived until all of his teeth and their alveolar processes had been lost, it is doubtful if the jaws, especially the lower one, would then be considered prognathous. If we accept this, we must admit that this prognathous character was caused by the forward position of the teeth and their alveolar processes. The distance of 71 mm. from the cutting edge of the incisor teeth to the hard palate is greater than in any other skull I have measured."

In considering this deformity, the influence of heredity must not be forgotten. The doctrine that "like produces like" is clearly defined here. The most pronounced cases are to be found in acromegaly.

Asymmetry of the Face.—In treating the subject of ankylosis of the mandible, asymmetry of the face was touched upon. The irregularity may be due to various causes, such as hypertrophy of the muscles of one side, dis-

FIG. 869.—Prognathous jaw which is characteristic of the West African tribes. (*Cryer.*)

turbances of the temporo-mandibular articulation, fractures, tumors, cysts, traumal facial paralysis, noma, adhesions from burns or disease, etc. It may be congenital also. Asymmetry of the face, as the expression implies, is a deformity, an absence of the normal symmetry or a face which is not properly proportioned. All faces are asymmetrical, though not perceptibly so. The most accurate measurements of faces regarded as perfect reveal a degree of asymmetry. The distance from the external canthus of the eye to the angle of the mouth on the same side is invariably greater on one side than on the other. The nose may be slightly diverted to one side without attracting attention, the eyes may not be similarly placed; elevation of the malar bones may differ; the mandible may be a little fuller on one side than on the other; the absence of teeth will lead to a depression opposite them. This is seen especially after the extraction of the cuspid tooth on one side. In such a case the normal contour of the face is lost and cannot be restored and sometimes it is very conspicuous. A deep nasobuccal groove forms. It is the

groove of old age. The absence of several teeth on one side always leads to facial depression which is easily discernible.

Treatment of Prognathism.—In the passing of years the domain of general surgery has done nothing to correct the protrusion of the maxillæ and, not until recently, has the general surgeon employed means to correct protrusion of the mandible. Retrusion of the maxillæ and mandible, with distressing deformities, has received little or no attention except from the dental surgeon. Schools of medicine have, with few exceptions, no professors of oral surgery, and therefore cannot efficiently teach methods of procedure in the treatment of oral deformities such as these. Prognathism can be treated only by orthodontists or oral surgeons until the medical curriculum includes this branch of learning. No medical college can afford longer to omit from its curriculum the teaching of diseases and malformations of the jaws, which are so prevalent, conspicuous and distressing. With the advance of medical education, let us hope that our colleges will teach the healing art in *all its branches.*

The results obtained by orthodontic methods in young subjects are very gratifying. To make a diagnosis of each case, outline the treatment required, construct, adjust and manage the appliances necessary calls for a knowledge of anatomy, constructive engineering and the manipulative skill of the manufacturing jeweler. Nor is this all the orthodontist must know. He must have a knowledge of how fast and how far teeth and bone can be moved with safety. The demands upon those who treat human ills are so exacting and require so broad a knowledge that it is absolutely necessary to divide the work because it is beyond human possibilities for anyone to become master of all. Yet all should recognize abnormalities in their early development and correct them or direct their patients to those skilled in the treatment of such conditions.

Treatment of Protrusion of the Mandible.—The treatment of this deformity may be very simple or extremely difficult. It depends upon the extent of the protrusion, the physical condition of the patient, his age, etc. It may be accomplished by orthodontic methods or it may require an extensive surgical operation. It is not wise to attempt to force the teeth and alveolar processes backward by orthodontia if the patient's physical condition is not good. Moreover, age is an important factor in reaching a conclusion as to what is best to be done. It is a well-known fact among orthodontists that efforts to move teeth in patients over twenty-five years of age have not been attended by the happiest results. The teeth move with difficulty and the absorption of sockets in the new location is slow. Besides, when they are moved into new sockets made for them by pressure, they often remain loose for a long time and, in some instances, they never become firm. In younger patients, however, the skillful orthodontist can move teeth and can also move the protruding alveolar processes backward, after which a well-formed retaining appliance holds them in position until they are firm. The apparatus here

illustrated (Figs. 870 and 871) will not only move the teeth backward in young subjects, but it will change the form of the bone, bending it so as to

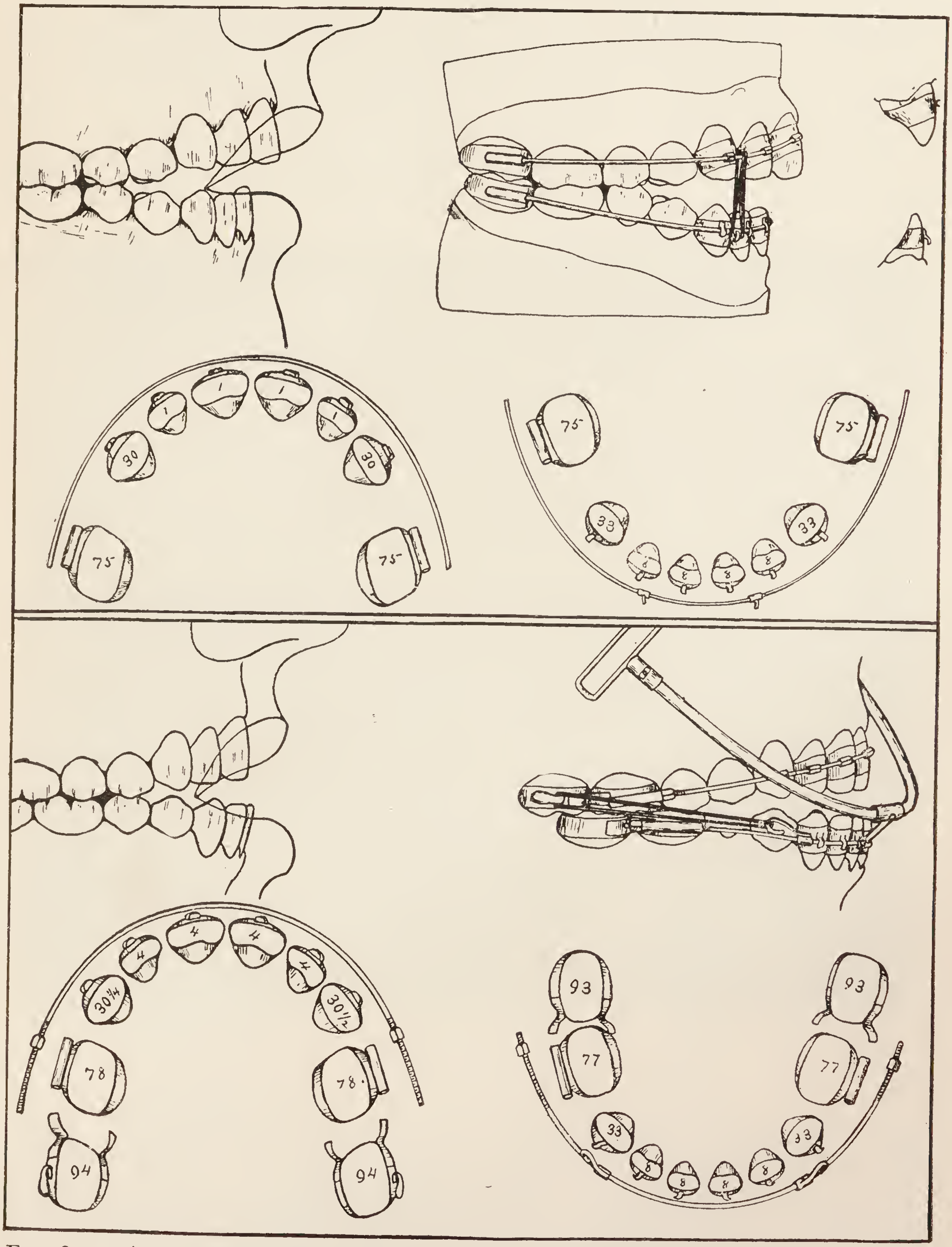


FIG. 870.—Apparatus employed in the treatment of protrusion of the mandible. (*Case.*)

bring it back to a normal position, thus enabling the upper teeth to lock over the lower. The head cap and elastic bandage worn at night will greatly aid in retracting the bone (Fig. 872). While this may be done in older

subjects, the deformity is sometimes so great and the bone so hard and dense as to make the change in form by orthodontic methods impossible. It is then that operative surgery is necessary.

We are indebted to V. P. Blair and to him is due the credit for conceiving the first operation for shortening the mandible, correcting its protrusion and establishing normal occlusion of the teeth. I quote from his text as follows:

"Where the lower jaw, as a whole, occupies a forward position, there will be also lateral protrusion, for two reasons: (1) The broader posterior part of

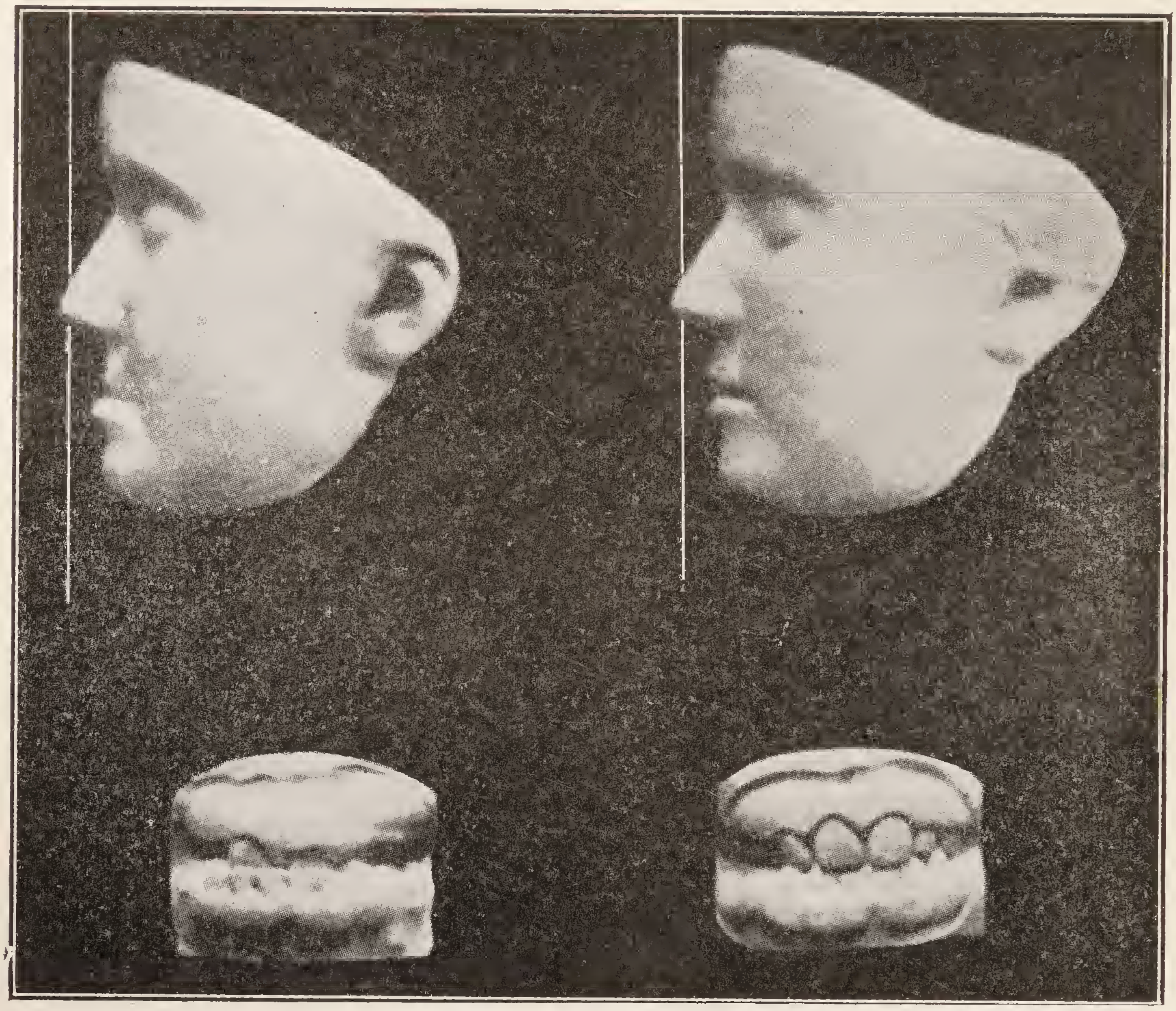


Fig. 871.—Illustrates the result obtained in a case by the use of the apparatus shown in Fig. 870. (*Case.*)

the lower jaw is brought opposite the anterior portion of the upper; and (2) when this occurs, the impact of the jaw is taken not on the buccal cusps of the lower molars, as is normal (Fig. 873), but on a point nearer the lingual cusps. This tends to rotate the lower molars lingually, which is accompanied by an outward rotation of the lower border of the bone. Thus we have a real spreading at the lower part of the body. This lateral protrusion must also be corrected or compensation made. Sections of the bone of proper size are removed and the fragments brought together. The cuts are illustrated in Figs. 874 and 875, by the lines (aa); (aa) and the sections (dd) are removed, then the

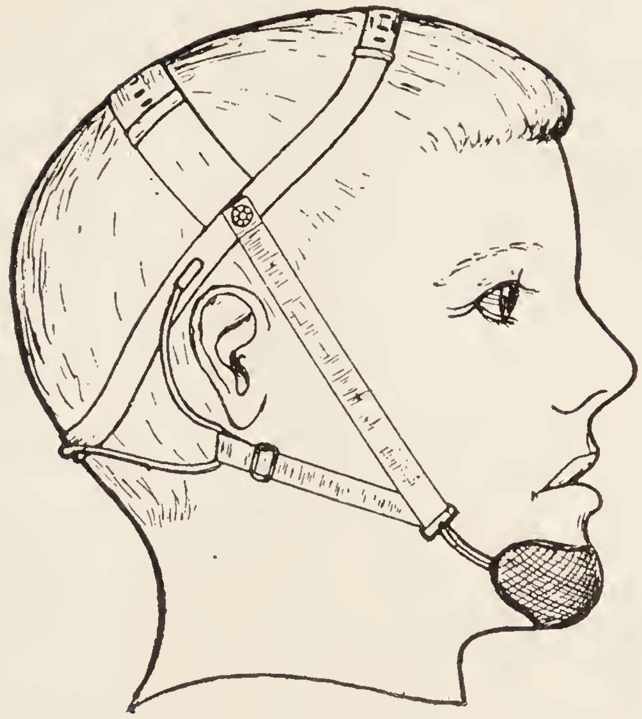


FIG. 872.—Head cap and elastic bandage worn at night for protrusion of the mandible. (*Case.*)

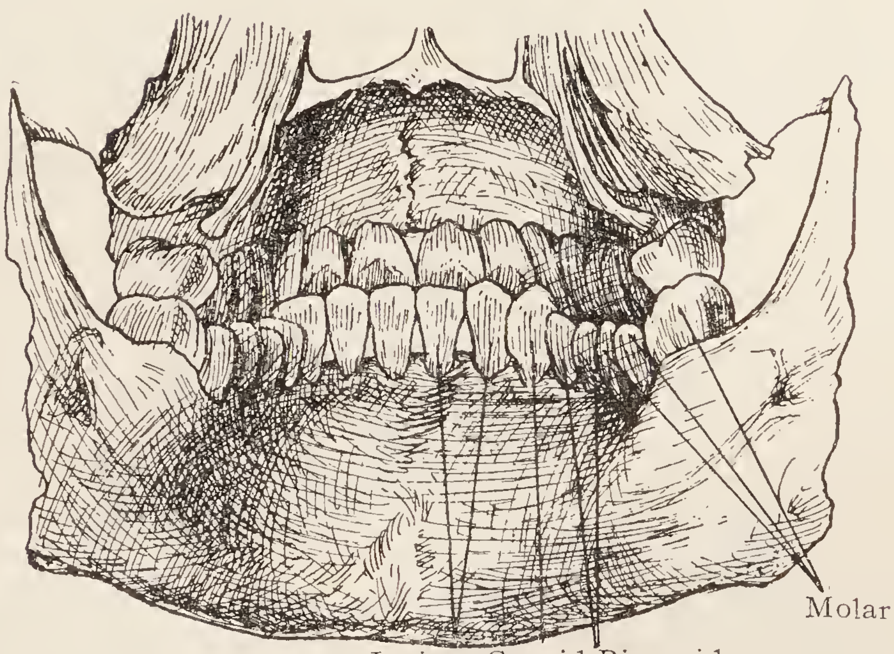


FIG. 873.—Occlusion of the teeth viewed from behind. It will be observed that the lingual cusps of the lower molar occlude slightly mesial to the lingual cusps of the upper, and that the incisors occlude behind the corresponding upper teeth. (*Blair.*)

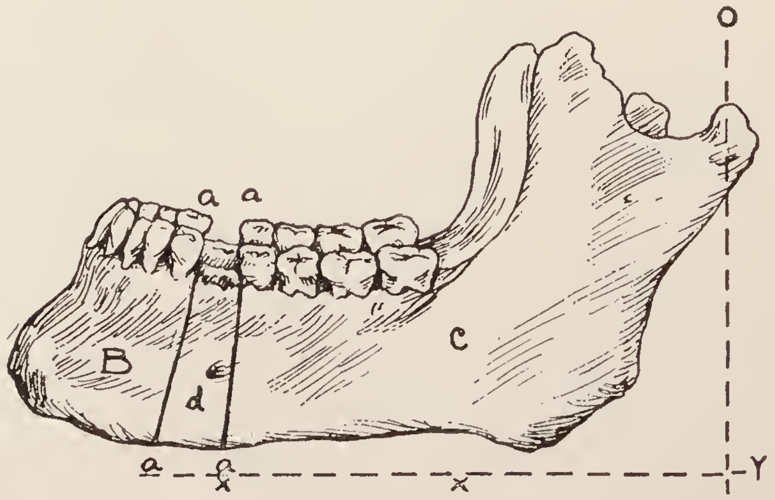


FIG. 874.—Abnormally long jaw with interdental spaces in the bicuspid region. Showing position of cuts for correction. (*Blair.*)

fragments (cbc), shown in dotted lines, are moved in and back to form the new arch (c′, b′, c′). The lateral fragments rotate on an axis corresponding not to the last molar tooth, but to the temporo-mandibular articulation (oy). Now, as the distance from the cut to the last molar (xx) is about one-half that from the cut to the axis of rotation (xy), the anterior end of the fragment will move in twice as far as does the last molar, which is about in proportion to the usual displacement of the two points. By this operation both the lateral and forward protrusions are corrected . . . . . The site of the bone cuts, the size and shape of the sections to be removed, and the means of retaining the newly constructed jaw are determined before the operation. We think the site of selection is at the second bicuspid, but one may be deterred from sacrificing these teeth by the presence of other natural or acquired interdental spaces. We once removed a section at the site of a missing second

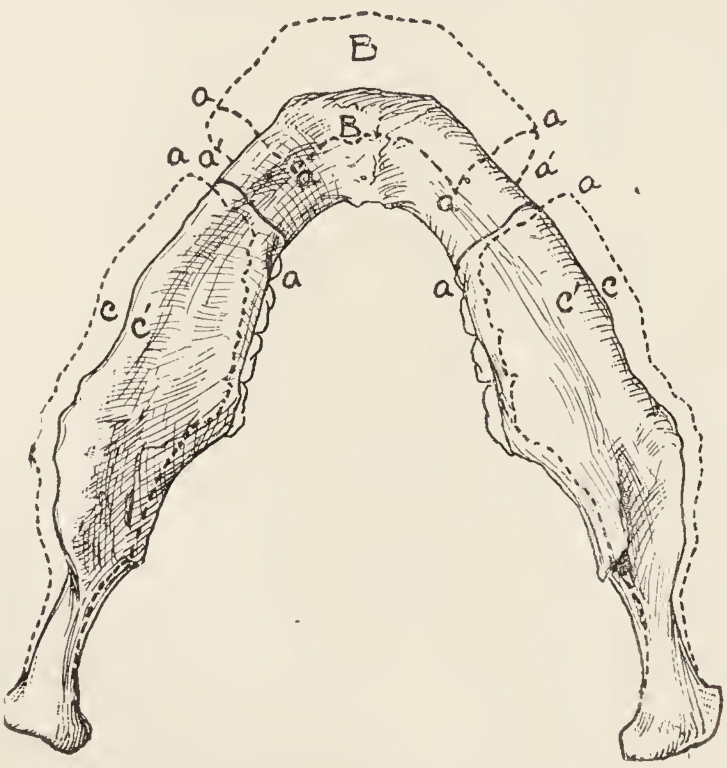


FIG. 875.—Reconstructed jaw, showing how both forward and lateral protrusion are corrected by removing bone sections. The dotted lines indicate the jaw-bone shown in the preceding figure. (*Blair.*)

molar on one side. If the submucous operation is to be done, the teeth are to be removed at least four weeks before the operation, but if it is to be an open operation, the teeth may be removed at the same time. In operating on the ramus, no teeth need to be removed."

Preparation for Operation.—After excluding all factors which might contra-indicate an operation, accurate plaster casts of the jaws should be made. The occlusion of the teeth of the model should be a counterpart of the natural one. The relation of the upper to the lower teeth is noted and the extent of the protrusion measured. Consideration of the maxillæ as to normal position of the teeth and alveolar processes is imperative. It may be necessary to give attention to the upper teeth and alveolar processes to move them into correct position before operating on the mandible. Once the maxillæ are expanded, the alveolar processes and anterior teeth moved forward, the relation of the lower and the upper teeth can be definitely determined. The amount of bone nec-

essary to remove can then be outlined with a view to reconstruct it. If the bone is divided at the second bicuspid tooth or the first molar, splints are constructed to be adjusted as soon as the section of bone is removed, and the parts are adjusted in their new relation. These interdental splints will hold the fragments firmly in quiet contact and assure the most satisfactory results (see Splints, in chapter on Fractures).

Surgical operations in the treatment of protrusion and retrusion of the mandible should be attempted only after most careful consideration of every feature of the case. The physical condition of the patient should be looked into, as one weakened by disease is not a favorable subject. The results are most promising in those who are healthy and robust. It must be remembered that we always encounter the dangers of infection and, with infection, the possibility of necrosis. Surgeons have selected different places for cutting the bone:

1. The ramus.
2. The angle.
3. The body, at the line of union with the ramus.
4. The body, at any place between the cuspid tooth and the ramus.

FIG. 876.—Photograph of the right side of skull, showing position of the teeth and the mark for incision in correcting protrusion of the mandible. (*Cryer, Dental Cosmos.*)

If the bone is cut just anterior to or through the ramus, no teeth need be extracted. However, if the bone is cut through the dental alveoli, teeth must be lost. Blair prefers the position of the second bicuspid tooth. Cryer recommends dividing the mandible in the same location which I have employed to establish an artificial joint.[1] He divides the bone on both sides and changes the angle so as to move the jaw backward or forward. This enables him to bring the mandible back to its normal position and fix it there, as in the case of a fracture, until union of the divided ends takes place.

He states, in part, as follows: "I wish to suggest an operation for anterior occlusion which cannot be otherwise corrected by ordinary orthodontic procedure. Several cases have been reported in which a section of the bone

[1]M. H. Cryer, Studies of Anterior and Posterior Occlusion, Dental Cosmos, July, 1913.

was removed from each side of the mandible, although there was no evidence shown that the length of the bone was at fault. . . . . . Wishing to experiment with a skull that had a marked anterior occlusion and an obtuse angle, and, failing to find one, I selected a skull that exhibited fairly normal occlusion and had its original capsular ligament in place. By cutting semi-

Fig. 877.—Illustration showing corrected position of the teeth after circular incision has been made in the ramus of the mandible. (*Cryer, Dental Cosmos.*)

circular incisions through the angles of the jaw, I was able to carry the body with the teeth forward, producing anterior occlusion and open bite. Fig. 876 is made from a photograph of the right side of the skull, showing the position of the teeth. The mark of the incision at the angle is shown, with two wire sutures to hold the ramus and body together. In carrying the body of the jaw forward, the angles are increased in proportion. If the wire

Fig. 878.—Showing the opposite side of Fig. 877. (*Cryer, Dental Cosmos.*)

sutures be cut, the jaw can be pushed back to its original position and occlusion, as shown in Fig. 877. Fig. 878 shows the opposite side of this jaw. The advantage in using a semicircular incision instead of a straight one consists in that it does not necessitate the removal of a V-shaped section or leave an open space (Fig. 879). If the artificial deformity of the jaw had been

natural, then the cutting of the semicircular incision, as described, would make a successful correction. . . .

In making this semicircular incision, I would recommend the use of a large fissure bur or a small spiral osteotome driven by the surgical engine; or it might be even better to use an ordinary cranial trephine with three-fourths of the circumference and the side cutting teeth taken away; then, by a to-and-fro motion, the bone can be cut through. In adjusting the jaw to the new position, any necessary removal of a little of the bone could be made by a small spiral osteotome. It may be possible, in some cases, to make the incision high enough in the ramus to avoid cutting the inferior dental nerve and vessels, or, if the incision were made so that the center of the curve could come above the inferior dental foramen, the severing of the nerve might be avoided. The parts could be held together by wire sutures, assisted by a maxillo-mandibular splint, which should be made before the operation. There would be no danger of septic conditions if the operation were performed with surgical care, but when a section is removed from the body of the bone, it is impossible to avoid infection."

FIG. 879.—Straight incision through mandible made in an attempt to overcome obtuse angle. This leaves an ugly V-shaped space. (*Cryer, Dental Cosmos.*)

The sub-periosteal operation is very difficult to perform without rupturing the membranes, but, when successful, has the advantage of excluding the oral secretion from the wound and, thereby, promoting asepsis. The difficulty in dividing the bone, without penetrating the membranes, is self-evident. The teeth should be removed at the location of the section of the bone at least two months before operation so as to allow the tissues over the tooth sockets to heal and become firm.

Blair's operation, which calls for the removal of the second bicuspid tooth, is made as follows:

The mouth having been prepared properly, the shoulders are raised and the head drawn back.

Fixing the Jaw.—In order to render the jaw rigid, a pine block is inserted between the molar teeth on one side behind the site of the proposed bone section. The jaws are closed firmly on the block and held there by wires passing between the molars.

Cutting the Bone.—Corresponding to the site of the bone which is to be removed, the skin lying under the border of the jaw is drawn upward and a

cut 2 to 2 1/2 cm. is made parallel with this border. This will render the scar inconspicuous when the operation is complete. The incision extends through the skin, fascia and platysma. The tissues are dissected from the outer surface of the jaw-bone, but without on any account injuring or even exposing the periosteum. The dissection is continued upward until the mouth is opened through the bucco-alveolar cul-de-sac, the mucous covering of the gum being left intact.

Before inserting the saw-blade, the exact position of the first saw-cut is determined, and a flat piece of metal may be inserted into the wound and turned on edge so as to rest against the bone just to the outside of and parallel with the first cut. This will serve both as a guide to the saw and protect it from the soft tissue which would deflect the blade from its proposed course. The handle of a knife or the blade of another saw can be used for this purpose, but if the edge that rests on the bone is toothed, it will not slip, and if the protector is fixed on a right-angled handle, it can be used with greater ease. No matter what kind of a saw is used, for obvious reasons the bone should not be cut entirely through in any place until the fixation holes are drilled near the lower border and all the other saw-cuts are at least three-fourths of the way through. We have a mechanical saw, very narrow and probe-pointed (a nasal saw modified), run by an engine and cable, that cuts very rapidly, but a sharp, narrow-bladed metacarpal saw will suffice and is probably safer.

Adjusting the Bone.—The bone sections having been removed, the new arch is formed by wiring the remaining fragments with silver wire, which was put through the holes drilled before the saw-cuts were made. The final twisting of these wires is not done until the intra-oral fixation is made.

Intra-oral Fixation.—The means of splinting the fragments is important. Hullihan, in 1850, for a case in which he had resected and replaced the alveolus, devised a continuous metal splint, cemented over all the teeth in the lower jaw (Fig. 142). We first tried wiring the bones and also the lower jaw to the upper. In commenting on a case of this kind on which we had operated, Dr. Angle suggested a metal splint made in three sections, which is to be cemented over the teeth before the operation. The portions of each side to be removed were not to be covered by the splint, and the adjacent ends of the splint were to serve as guides in the sawing. When the bone is removed, the ends of the three pieces of splint are fastened together. We have not found it practical to make the splint serve as a saw guide, but Figs. 880 and 881 show a modification of Angle's idea, made for us by J. A. Brown, D. D. S., which worked satisfactorily. The use of such a splint allows the mouth to open. We would not dispense with the lower fixation in this operation. Proper fixation here consists of fastening the cut bones with silver wire or with chromicized catgut at their lower borders, and for the upper fixation using the Angle splint or wire. In wiring, the teeth adjacent to the cuts should not be used. It will be much better to have bands, carrying

rings on their buccal surfaces, attached to teeth just beyond those bordering on the cuts; that is, if the bone section is removed from the site of the second bicuspid, the cuspid and second molar will carry the bands. Bands are placed on upper teeth that will correspond to the bands below after the jaw

FIG. 880.

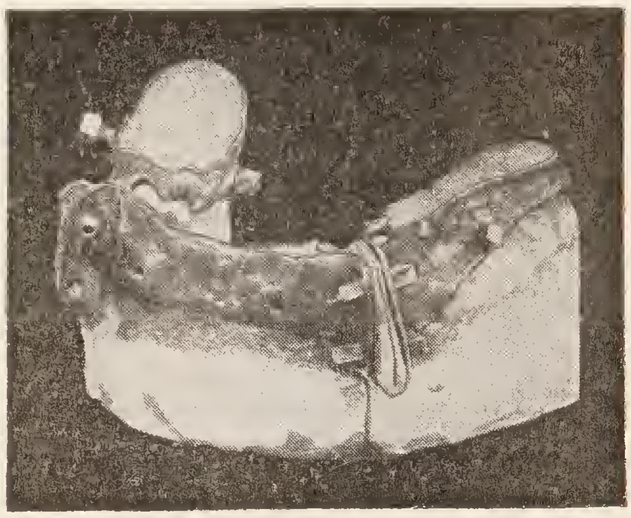


FIG. 881.

FIG. 880.—Lateral view of Angle splint, showing flanges drilled for bolts, and also bicuspid teeth that were removed at operation. (*Blair.*)

FIG. 881.—Angle splint after operation, lateral view. To allow for inaccuracies, the distance between the flanges was made larger than the section of bone to be removed. After operation the space between the plates was filled with a piece of lead plate, beaten and cut to the proper shape. (*Blair.*)

is cut. The fixation is made by passing a wire between the two lower bands and between each of the lower bands and the one above (Fig. 882). Here solidity will be gained by placing cement or softened gutta-percha at proper places between the occlusal surfaces, but space must be allowed for the taking of liquid food. We consider this the best plan of fixation.

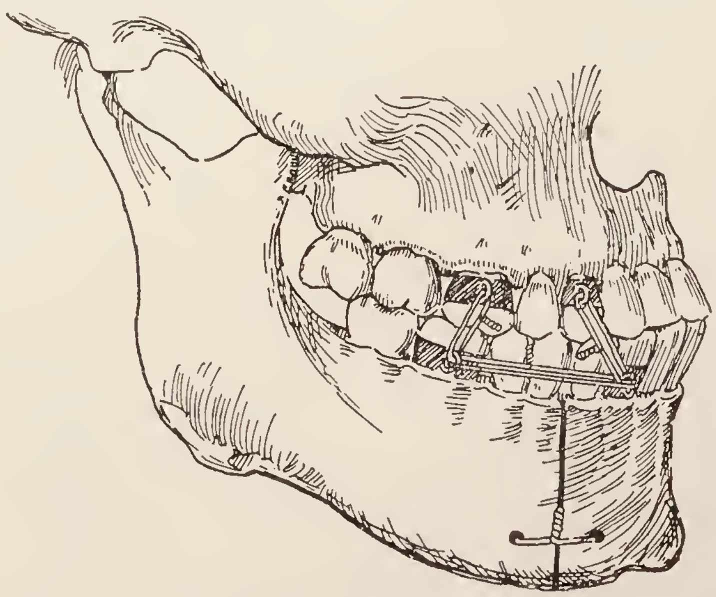


FIG. 882.—Fixation of the jaw by wires and bands, after removing a section from the body. The lower wire should be shown, bent downward. (*Blair.*)

The intra-oral fixation and the lower fixation should be done together so that neither one will throw the other entirely out of balance, as might be the case if the cuts were badly made. The teeth can be moved later, and it is not necessary to have absolutely accurate bony contact.

The bone wires are twisted, bent down and cut at the lower border of the jaw so that they can be found if it is necessary later to remove them.

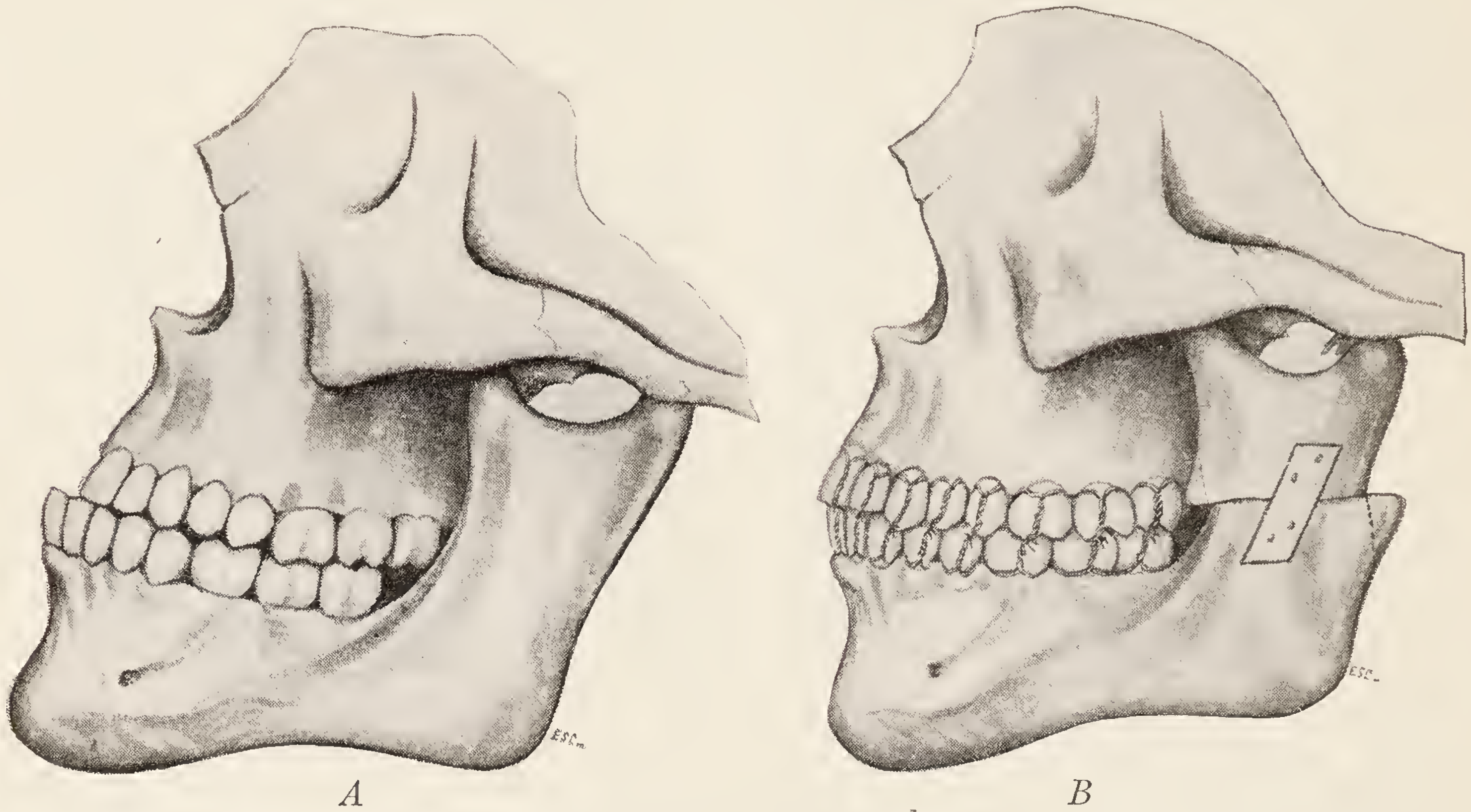


FIG. 883.—Protrusion of the mandible, the treatment of which was suggested by Sir Arbuthnot Lane.

The deep part of the wound is closed with interrupted No. 00 tannated gut, and the skin is closed with interrupted silkworm gut. A small spirally split

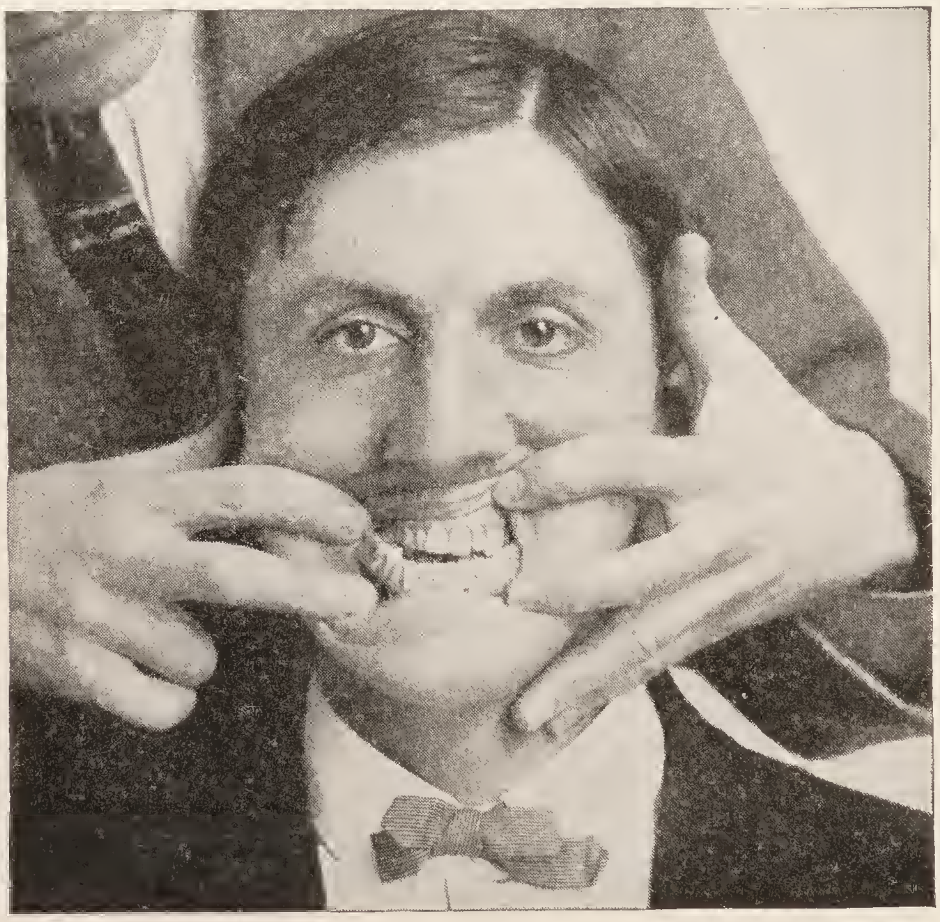


FIG. 884.—Front view of occlusion, showing telescoping of the upper teeth by the lower teeth. (*Harsha, in Surg., Gyn. and Obst.*)

tube or fold of rubber dam is to be led to the bone cut and sutured into the skin.

If the wound heals primarily, the sutures may be removed in four days. If the wound suppurates, unless there is a virulent infection, some of the sutures should remain until there is no danger of the wound gaping."

During his visit to the United States in 1913, I asked Sir Arbuthnot

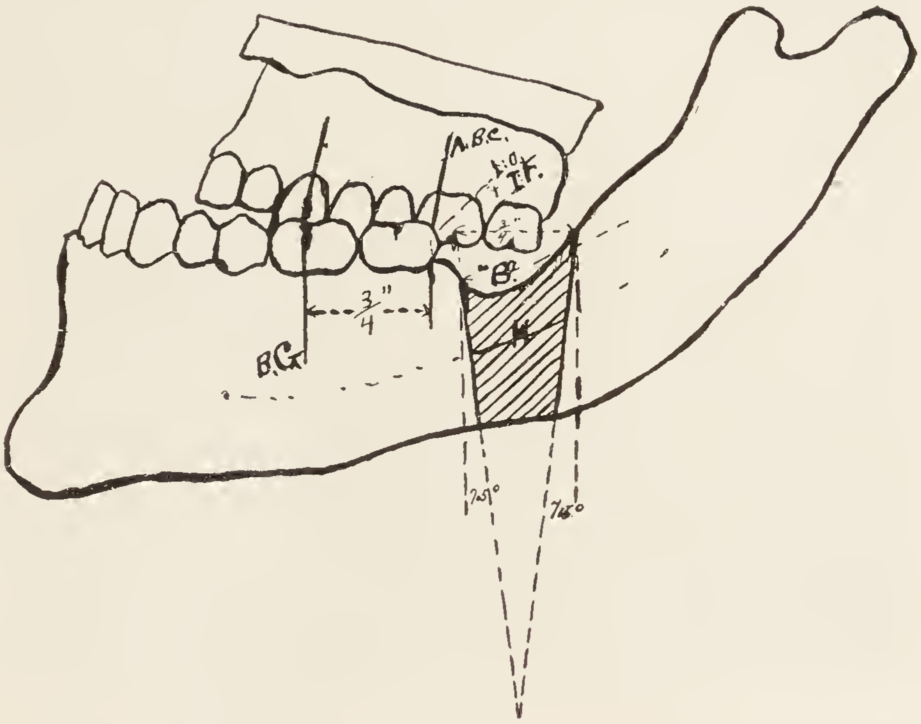


FIG. 885.—Left side showing form of segment. (*Harsha, in Surg., Gyn. and Obst.*)

Lane how he treated protrusion and retrusion of the mandible. His reply was that he transversely divided the ramus and moved the body of the bone either forward or backward as required to correct the deformity. To perform this operation, an incision is made just posterior to the ramus, using great care to avoid dividing the facial nerve. A complete division of the ramus

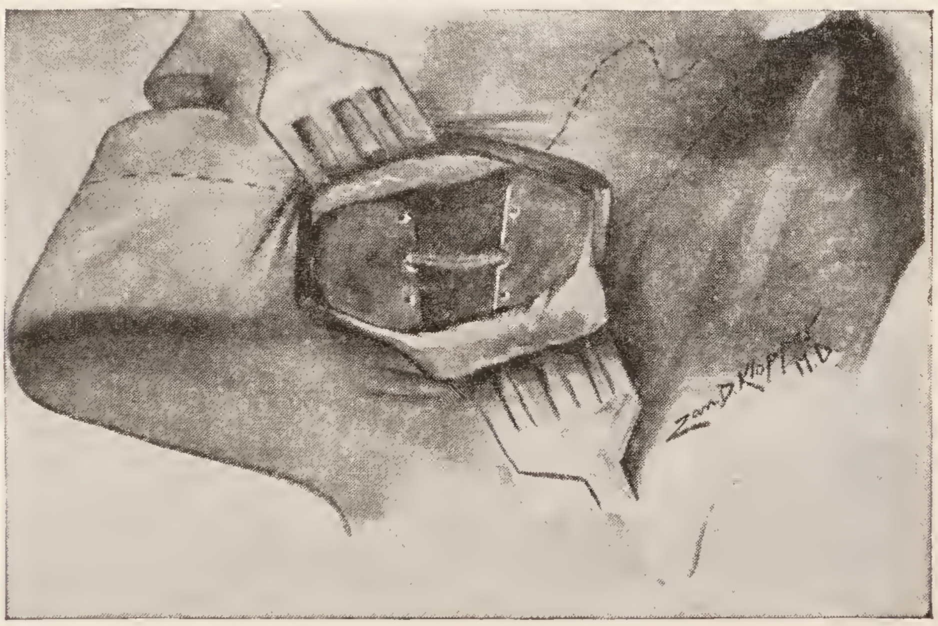


FIG. 886.—Operative field showing space left after removal of bone segment with dental nerve in place. (*Harsha, in Surg., Gyn. and Obst.*)

is made, as indicated in Figs. 883, 892 and 893. The operation described by Sir Arbuthnot Lane does not interfere with the teeth and no visible scars are left.

Dr. Harsha of Chicago, in a recent article,[1] describes an operation for cor-

[1] Surg., Gyn. and Obst., p. 51, July, 1912.

recting protrusion of the mandible. He divided the bone and preserved the mandibular nerve. (The preservation of the mandibular nerve is not essen-

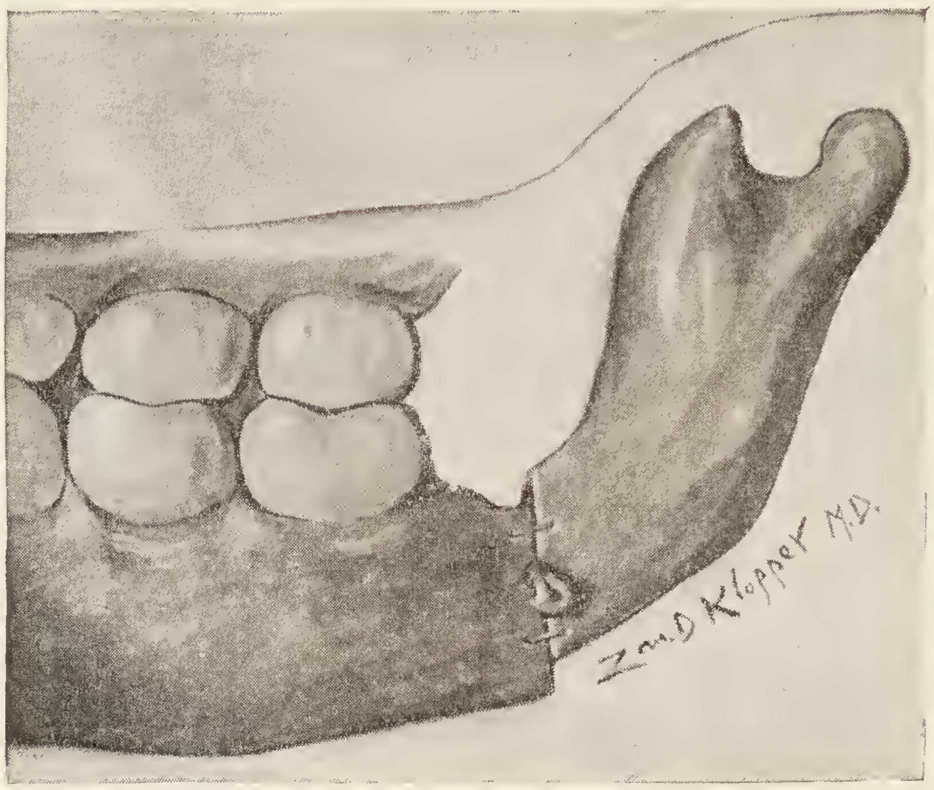


Fig. 887.—Shows relation of fragments, after being wired, with occlusion of molars and new mandibular angle produced. (*Harsha, in Surg., Gyn. and Obst.*)

tial, since the parts are richly supplied by the sympathetic system.) After removing a section of the bone, the anterior portion of the mandible was carried back and firmly wired to the posterior portion. The cosmetic effect

Fig. 888.—Photograph eight months after operation. (*Harsha, in Surg., Gyn. and Obst.*)

produced was gratifying, besides the occlusion of the teeth was good (Figs. 884 to 888).

Treatment of Protrusion of the Maxillæ.—Surgical literature devotes little or no space to this deformity. The orthodontist is, therefore, appealed to for the necessary treatment.

Protrusion of the maxillæ, or parrot-jaw, when extensive, is more difficult to correct than protrusion of the mandible. Not infrequently the arch is narrow, the teeth crowded and the bone develops far anterior to its normal position. By spreading the dental arch and making pressure on the incisor teeth with the apparatus here exhibited (Fig. 889), the teeth, with the bone, may be retruded into normal condition. In extreme cases a bicuspid tooth on each side may be removed to advantage and teeth moved backward to close the space. Teeth should never be removed to correct this deformity or irregularities without advice of an expert orthodontist. The teeth and alveolar processes must be moved slowly, especially at the beginning. Too much pressure will not only be painful, but may endanger the vitality of the teeth, thus

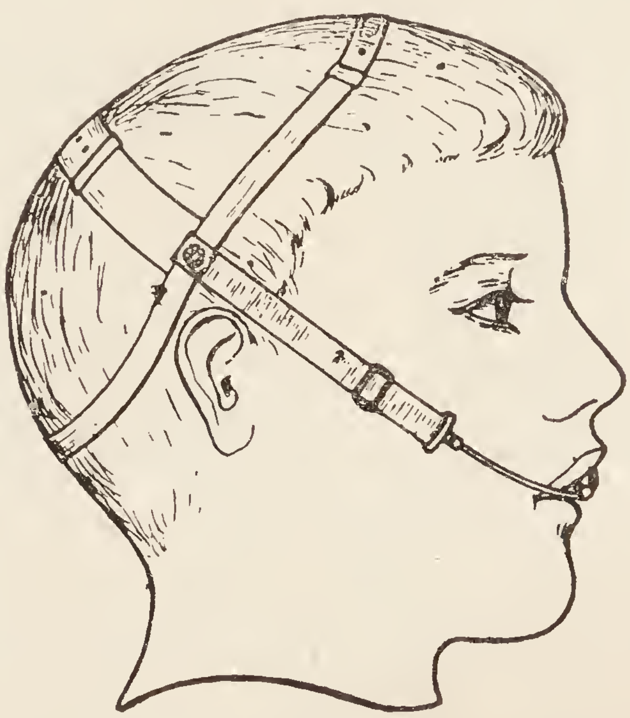


Fig. 889.—Head cap and bandage worn at night for protrusion of the maxillæ. (*Case.*)

causing a great deal of unnecessary suffering. Protrusion of the maxillæ may be so extensive, the deformity so great and the patient so old as to render orthodontic methods for its correction impossible. In such a case surgical procedures often necessitate the removal of the anterior teeth, after which the prominent bone should be sufficiently chiseled away to produce a normal profile. This should not be done, however, except in extreme cases and only as a last resort. After the six anterior superior teeth have been extracted, an incision is made from the first bicuspid on one side to the same point on the other along the alveolar border of the bone. The periosteum is elevated as high as need be to expose the bone to be removed. The anterior portion of the alveolar processes is then chiseled away. It may be necessary to remove some of the body of the bone to overcome the deformity. The soft parts are then sutured in place and a pad of gauze is inserted under the lip so as to hold the flaps in close contact with the bone. I have had occasion to remove

the anterior alveolar borders in edentulous maxillæ many times to overcome protrusions which still remained after the upper teeth were lost.

Treatment of Retrusion of the Maxillæ.—Retrusion of the maxillæ, to the extent of causing a deformity, is not common. It is less frequent than other abnormalities of the jaw and, when extreme, it is most difficult to correct. When the deciduous teeth are prematurely lost, this deformity may result. It may be caused by the early loss of the cuspids, bicuspids and the first molar teeth. The loss of these teeth permit the alveolar processes of the maxillæ to recede. The mandible protrudes and the development of the maxillæ for

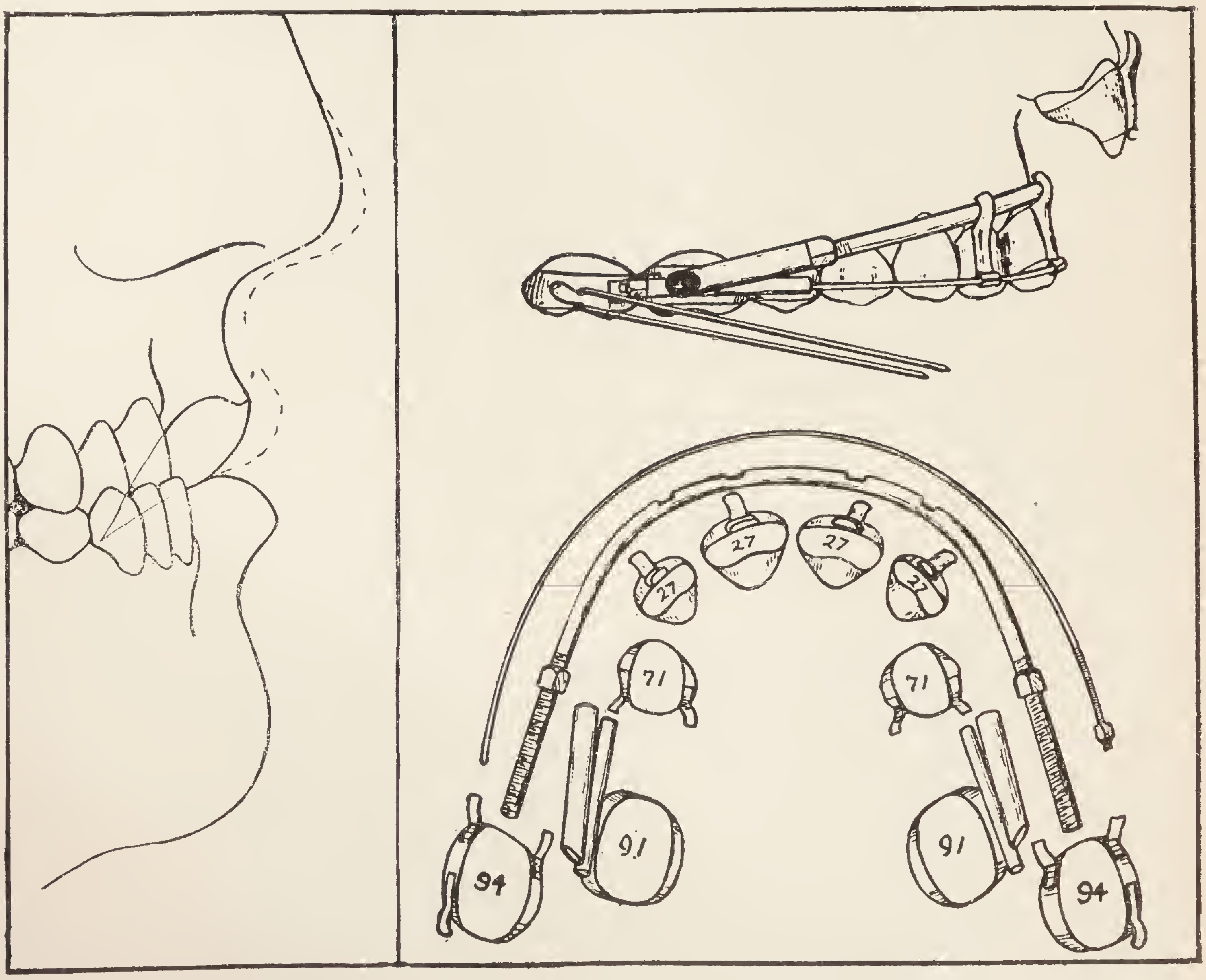


FIG. 890.—Apparatus for correcting retrusion of the maxillæ. (*Case.*)

want of the assistance of the mandible and lower teeth to press them forward is dwarfed. As stated before, the mandible protrudes further and further, giving the maxillæ the appearance of greater recession than really exists. The treatment is accomplished by orthodontic methods. The appliance here illustrated (Fig. 890), skillfully used, will bring the teeth and bone out to their proper positions. The force must be applied so as to move the parts slowly and the distribution of it such as to move the mandible backward.

Treatment of Retrusion of the Mandible.—A great deal can be accomplished by making traction and moving the lower jaw and teeth forward, using the upper teeth for attaching the appliance. In most all retrusions of

the mandible, there is, to some extent, a protrusion of the maxillæ. The adjustment of the mandible, therefore, calls for moving the maxillæ and labial teeth backward. An appliance for accomplishing this work is well illustrated by Fig. 889. In the developing child the mother or nurse may accomplish a great deal by making use of digital manipulations as follows: Standing behind the child, place the first and second fingers of both hands in the mouth and the thumbs on the posterior border of the ascending ramus just above the angle. Make gentle pressure forward with the thumb while the fingers carry the body of the bone downward. The young bone is bent easily, the angle slightly changed and the body moved forward. This treatment must be systematic and faithfully carried out. To achieve success, this treatment must be employed two or three times daily.

Surgical treatment embraces two distinct operations. Cryer performs an operation by dividing the bone just anterior to the angle. He makes a crescent incision, thus changing the relation of the body to the ramus. The

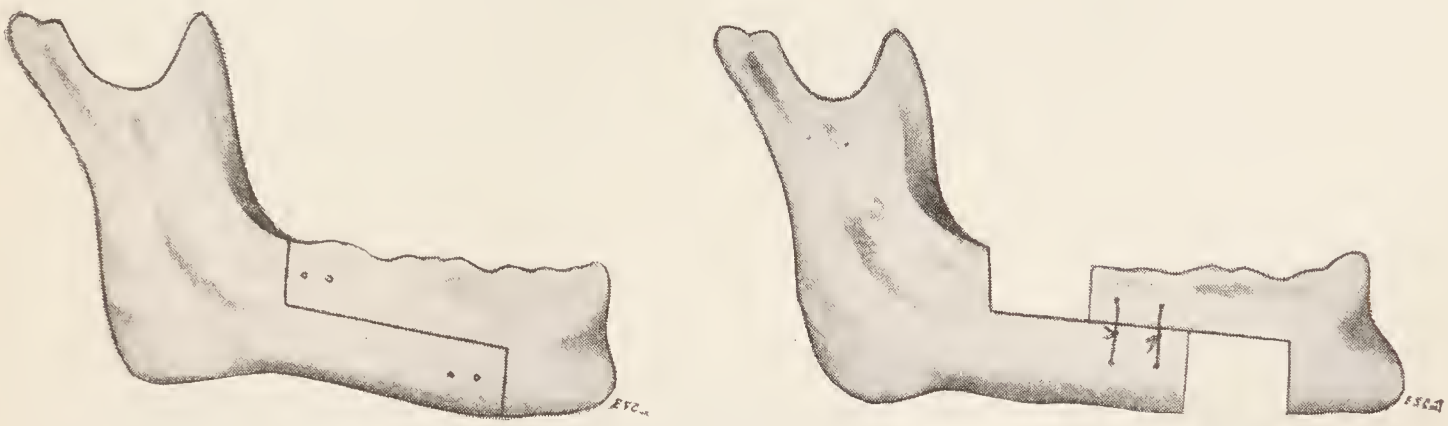


Fig. 891.—Pehr-Gadd's method of treating retrusion of the mandible.

angle is converted from a right angle to one about 45°. The symphysis is thus moved forward (Fig. 876).

The second operation, described by Lane, is illustrated in Figs. 892 and 893.

Treatment of Protrusion of Both Jaws.—Protrusion of both jaws may be greatly improved by the use of attachments to the teeth, with cap and chin piece, by which the teeth and alveolar processes are gradually moved backward into their proper place. However, this cannot always be done without extracting four bicuspid teeth.

Protrusion of both jaws does not appear in infants usually. It is a condition which develops with the eruption of the teeth. Certain forms of prognathism of both jaws are more fancied than real. The bone proper may not be abnormally prominent, but the protrusion is due to the extreme prominence of the teeth and alveolar processes. To correct this, aside from orthodontic methods, the extraction of all the anterior teeth has been done. The dentist or surgeon should not employ this method without careful consideration.

Treatment of Asymmetry.—The treatment of asymmetry of the face must necessarily depend on the cause. As it most frequently results from mal-

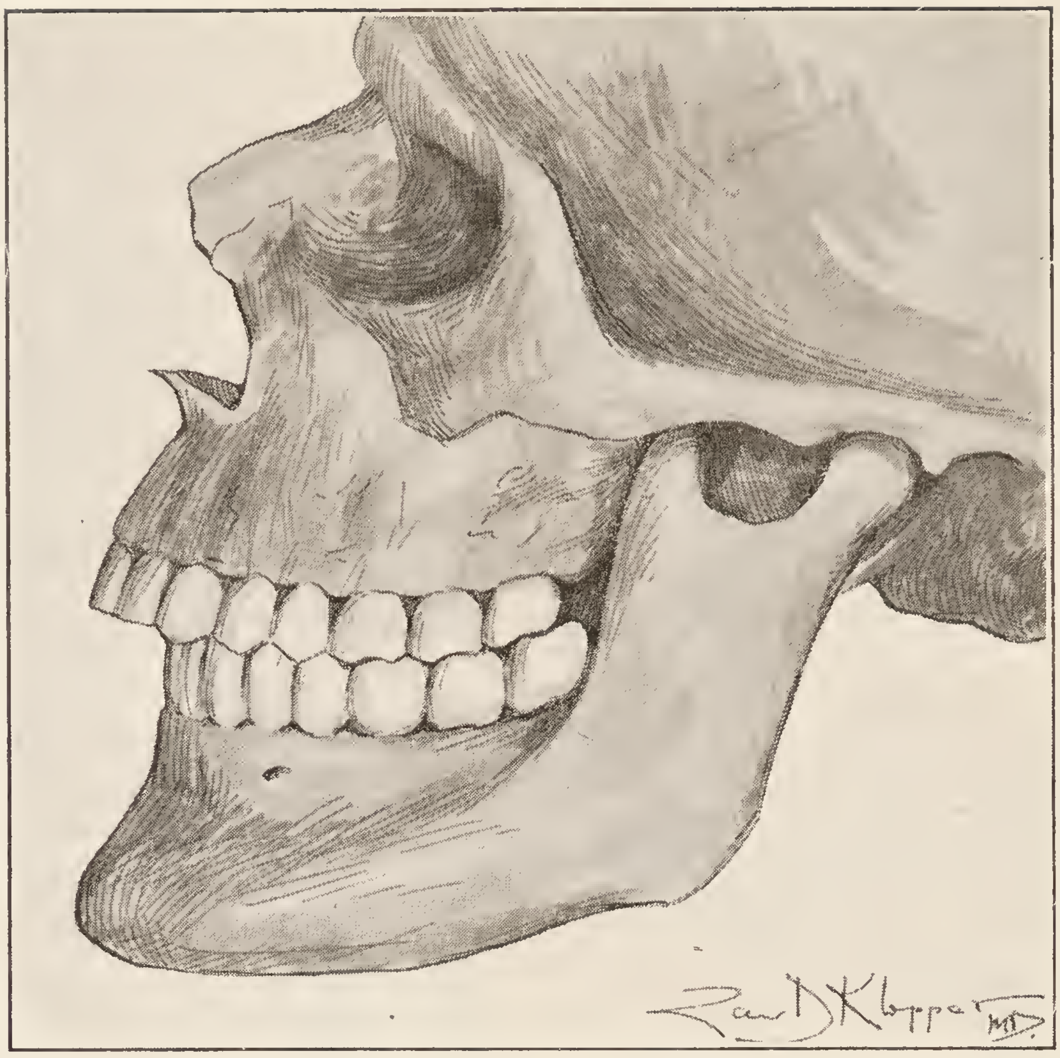


FIG. 892.—Retrusion of the mandible treated by the Lane method.

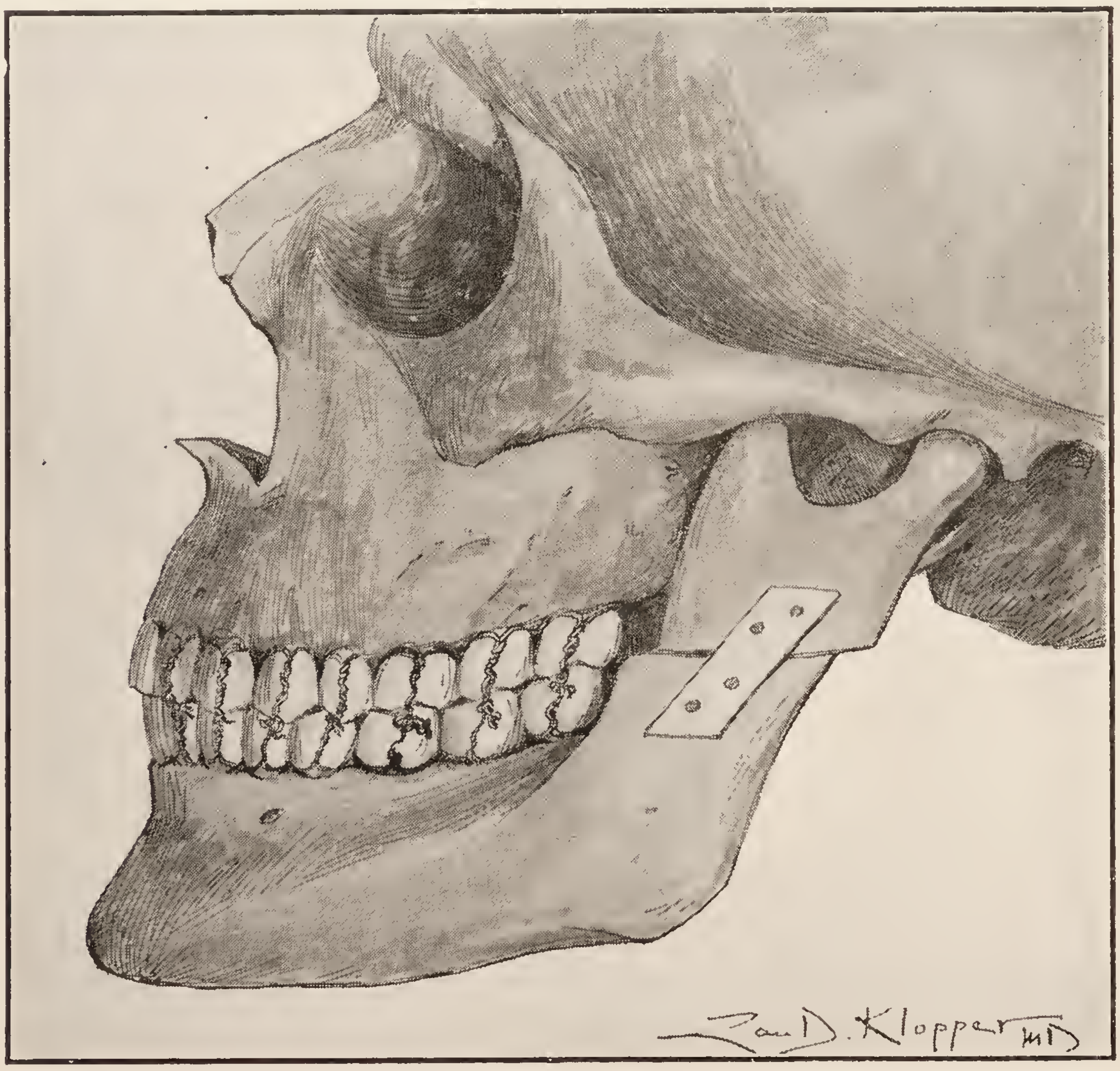


FIG. 893.

occlusion of the teeth, these conditions should receive the attention of the orthodontist. If due to paralysis, stimulation of the nerves by electricity, massage, etc., is indicated. In certain cases the nerves have been divided in operation and union has not taken place. The ends of the nerves should be picked up, approximated and sutured. The function should be re-established.

If asymmetry is due to adhesions resulting from burns, injuries, etc., the cicatricial tissue should be removed and the function of the parts re-established. The necessary operation has been discussed. (See Plastic Surgery.)

When resulting from fracture of the nose, malar bones and the mandible, asymmetry may be extreme. Paraffin and plastic surgery may completely remove the defect. The loss of certain teeth always leads to a change in facial expression for the skill of the dentist has not been able to overcome this. The large, long, somewhat flattened roots of the cuspid teeth are immensely important in preserving facial contour. The loss of one of these teeth will cause a deep depression of the lip at the ala of the nose because the alveolus consolidates and, consequently, the soft parts shrink. The side thus affected bears a striking contrast to its fellow. The elevation of the deep groove at the side of the nose may be overcome by the use of paraffin injections.

CHAPTER XLIV

DISEASES OF THE LIPS

One of the principal lesions of the lips is the congenital malformation known as "harelip." This has been treated previously in Chapter XXIV. Other lesions of the lips will be taken up in this chapter.

Macrocheilia.—Macrocheilia is a hypertrophy of the lip and is most frequently due to a distention of the lymphatic spaces. It may be either congenital or acquired (Fig. 894). The lower lip is affected most often and the thickening causes it to become everted. This produces a marked deformity. In the acquired form the condition is due to a chronic lymphangitis, which re-

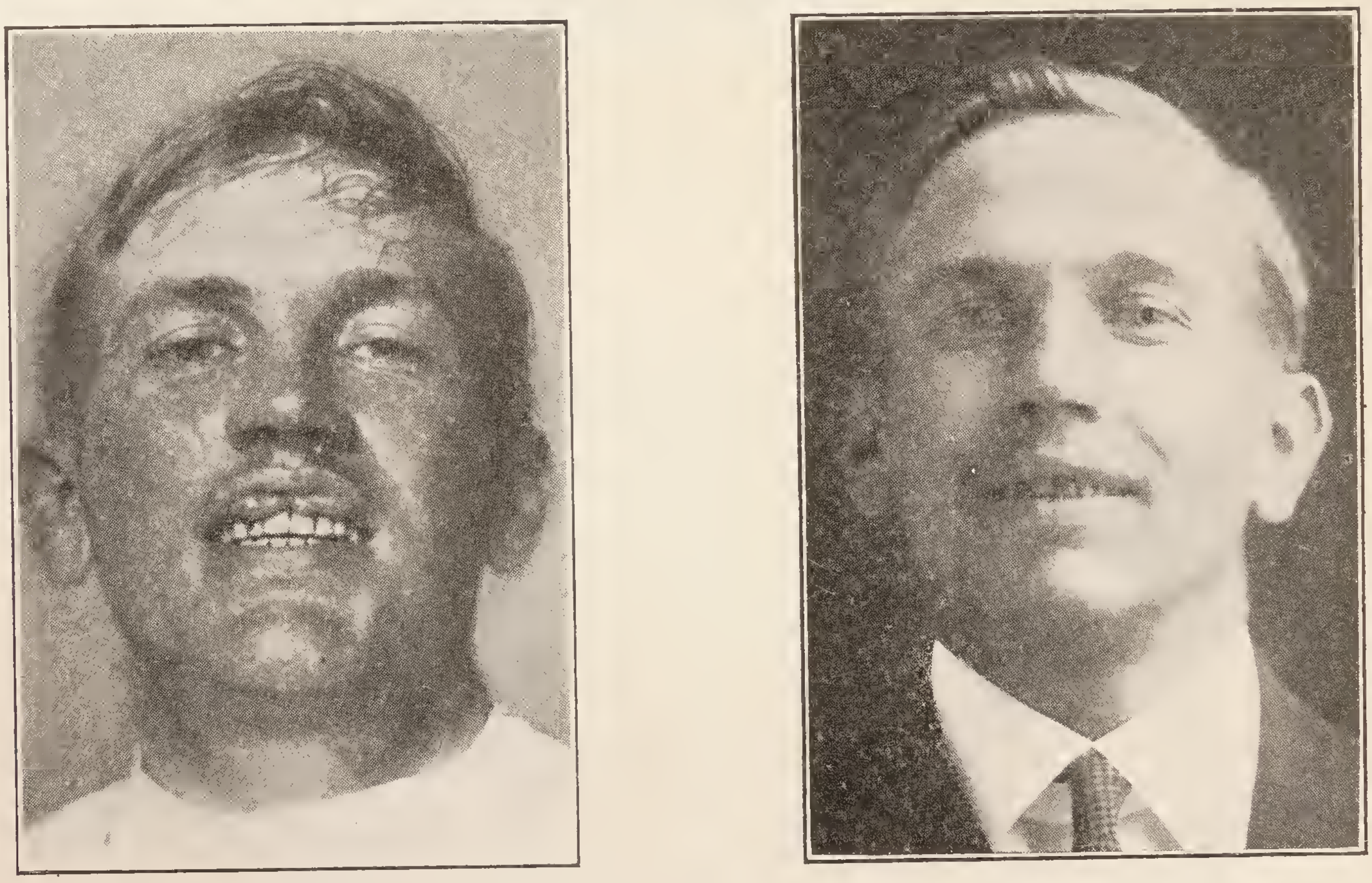


FIG. 894.—Hypertrophy of upper lip before and after operation.

sults from the absorption of toxins through cracks or fissures. The acquired form is usually seen in young people or children, especially those who have a tendency toward tuberculosis. The acquired form in adults is due most frequently to syphilis. In all of these the lower lip is affected more often. The treatment of the congenital form consists in removing a V-shaped portion from the center of the lip. A long incision should be made lengthwise of the lip, midway between the lower border and the gingivo-labial groove. Sufficient tissue is removed to restore the lip to the normal form. In the acquired form, due to a tuberculous tendency, the fissures should be healed

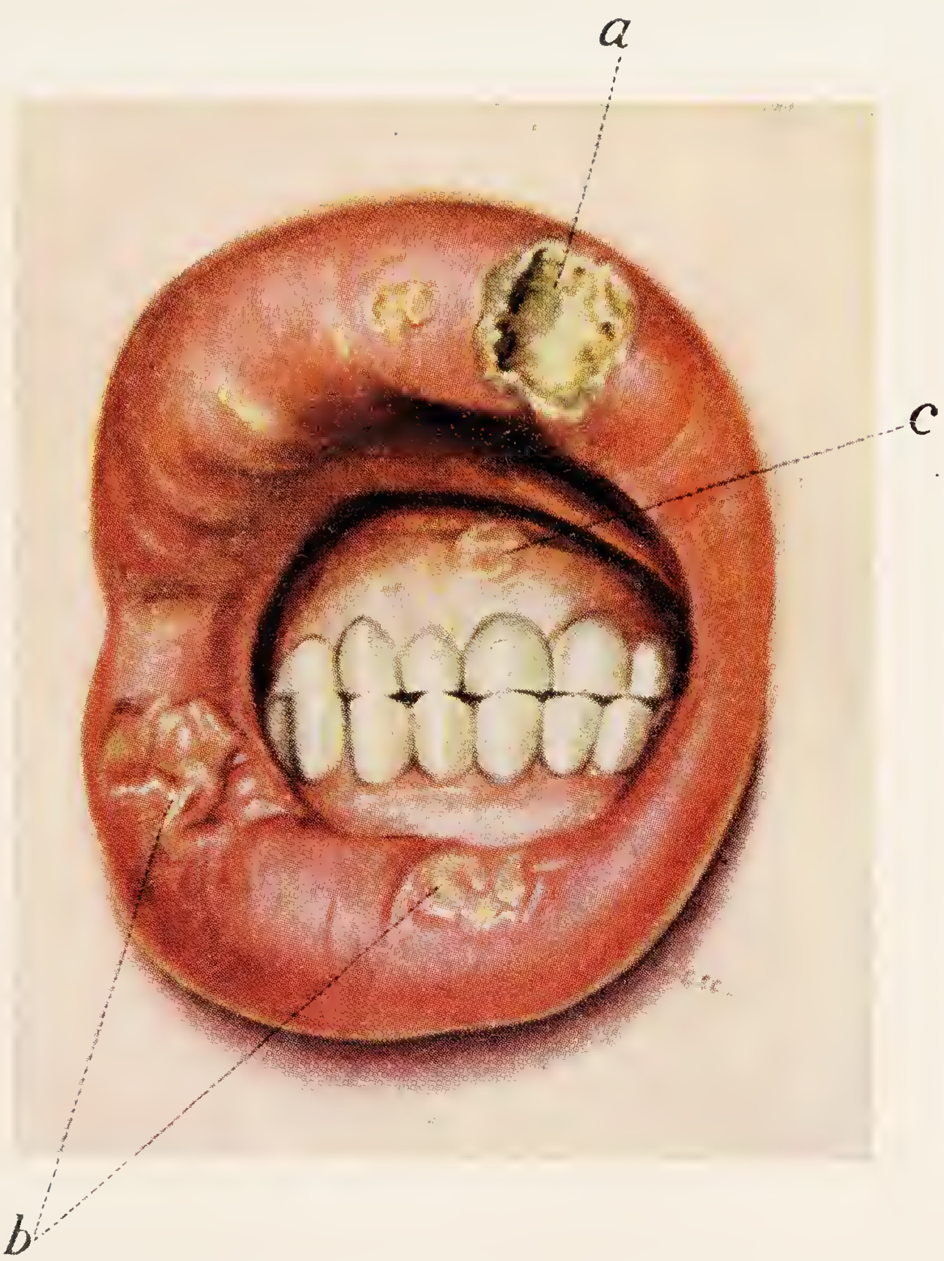


FIG. 895.—Syphilitic mucous patches of the lips. The lips are swollen. *a*, Ulcerated mucous patch. On the base of the ulcer is a yellow coating with dried secretions about its borders. *b*, Ulcerations which are not as far advanced as *a*. *c*, Mucous patch. (*After Zinnser-Stein.*)

FIG. 896.—Tuberculosis of the upper lip and gum, showing the tubercles. (*Royal College of Surgeons.*)

and the chronic lymphangitis will disappear. In the form resulting from syphilis, anti-syphilitic treatment will clear up the condition.

Syphilis of the Lip.—Chancre of the lip is the most frequent syphilitic lesion found and is caused by kissing or drinking from a glass which is infected with the virus (Fig. 895). The lesion differs little from that seen elsewhere in the body. It makes its appearance as a smooth, ulcerated surface, covered by a small amount of sero-pus. The induration is not marked and the submaxillary lymphatic glands become enlarged early. Chancre of the lip may be mistaken for an epithelioma, but its rapid development and the early involvement of the lymphatic glands and the absence of cachexia will rule it out.

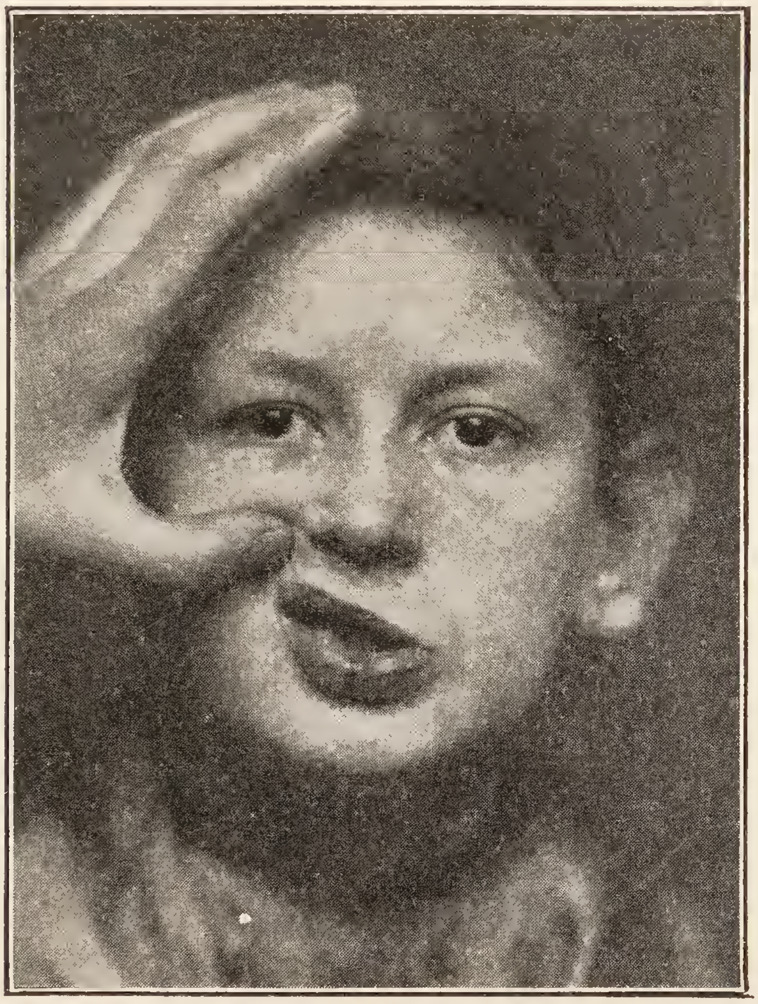


FIG. 897.—Mucous cyst on the lower lip.

Mucous patches and gummata are found occasionally on the lip. They do not differ in any respect from similar lesions elsewhere on the mucous membranes. The infiltration, however, is usually more marked. The treatment consists in the administration of the usual remedies for syphilis.

Tuberculosis of the Lips and Gums.—Tuberculosis of the lips and gums is rarely seen except in the terminal stages of pulmonary tuberculosis. Lupus of the lips may be seen. It does not vary any from lupus elsewhere. Fig. 896 illustrates a case of tuberculosis of the gums.

Herpes of the Lip.—Herpes of the lip is seen very frequently, associated with a mild catarrhal condition of the mucous membrane of the mouth or nose. In pneumonia, typhoid and other fevers, it is a usual accompaniment. The disease starts with the appearance of a few vesicles which are situated

upon a hyperemic and painful base. In the course of a few days, the clear fluid in the vesicles changes to pus and these burst. A yellowish crust is then formed and the lesion dries. The treatment consists in protecting the vesicle by means of a bland oinment.

Cracked Lips.—Cracked lips are seen most frequently in cold weather and on those exposed to the wind. The lower lip is affected more often, the crack being central in location. It is extremely painful and bleeds readily on everting or stretching the lip. The application of a bland ointment, such as lanolin, will usually relieve the condition. In chronic cracked lip with a great deal of scar tissue, the defect can be cured best by an operation which consists in removing the scar tissue and suturing with horse-hair.

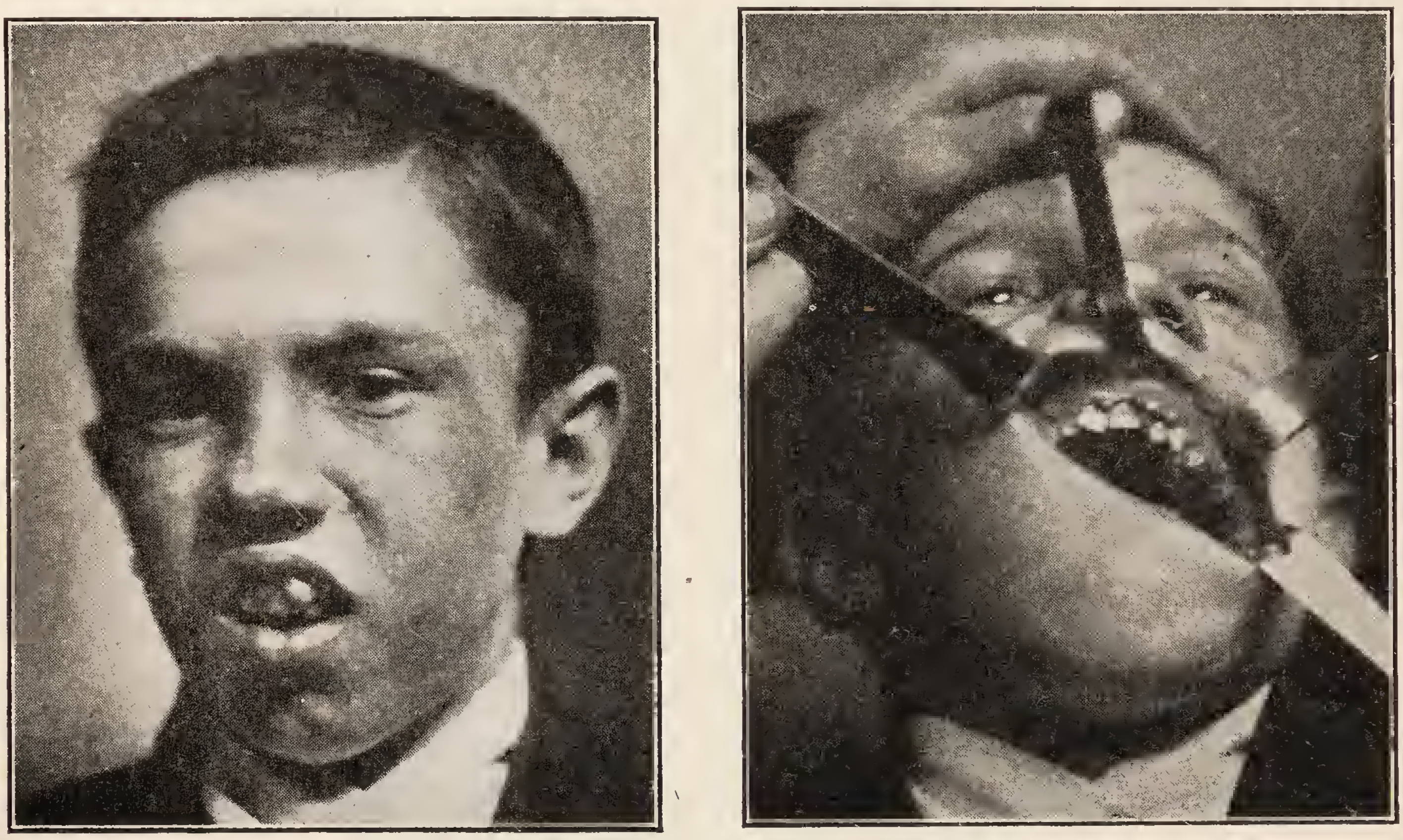


Fig. 898.—A nevus which involves the lip together with the left half of the face. The left maxilla was also involved. The growth extended downward so as to cover nearly all the teeth and interfered with occlusion. The maxillary growth was removed. The teeth and the alveolar processes were removed. The wound healed by primary union. Prosthesis was inserted later.

Mucous Cysts.—Mucous cysts of the lip are rather rare (Fig. 897). When seen they have a small rounded appearance and are translucent. They usually follow some slight trauma which causes a blocking of the opening of the mucous gland. The cyst contains a glarry fluid. If small, it is sufficient to puncture them, but if they attain a large size, it is better to dissect them and close the wound with horse-hair or silk sutures. Such cysts often accompany double harelip (page 559).

Nevi.—Nevi are very often found on the lip (Fig. 898). They cause little inconvenience, but are sometimes disfiguring. When they are located on the inner aspect they may be excised, but if they involve the whole thickness of the lip, this treatment is inadvisable. The electric needle may be used in the latter case.

Warty Growths.—Warty growths occasionally simulate epithelioma and are located usually on the lower lip near the angle. These growths do not ulcerate nor involve the lymphatic gland. Owing to the fact that epithelioma may develop from this growth, it is advisable to remove it as early as possible.

Angioma.—Angiomata rarely occur before the twenty-fifth year. I have seen more cases in women than in men. Angioma of the lips are frequently associated with nevus maternus. An angioma of the lip is a tumor composed of blood-vessels which lie in an irregular mass resembling a rope which has been thrown into a heap without any thought of winding it into a regular coil. The walls of these vessels have been greatly dilated and are consequently much thinner than normal. Hemorrhage occurs from the slightest cause. In its inception the tumor is not large. It may soon assume an enormous size. Following a hemorrhage, the size of the angioma

Fig. 899.—Angioma of the upper lip. The growth was removed intra-orally.

Fig. 900.—Same patient two weeks after operation.

decreases. After a few days the vessels again become engorged and the distension of the parts recurs. Angiomata are seen more frequently on the upper lip.

Fig. 889 illustrates an angioma of the upper lip occurring in a woman who came to me after having been operated upon twice before. The patient had been suffering from hemorrhage about every third day. Her vitality had been greatly reduced as a result. The tumor was large and involved the lip and the tissues of the cheek. At her first operation the surgeon removed a great portion of the tumor. At the second operation the coronary arteries were tied. The size of the tumor was reduced for a time, but as soon as the collateral circulation was established, the growth recurred. I decided to remove the entire mass, including all the network of vessels that composed the tumor.

The lip was reflected upward and an incision was made throughout the length of the dental surface of the mucous membrane. The hemorrhage was profuse following the incision, but by rapid work, all the engorged blood-vessels were removed. The coronary arteries, together with all the other vessels communicating with the tumors, were ligated. The redundant mucous membrane, which had developed during the growth of the tumor, was removed and the wound closed by horse-hair sutures. A further precaution against hemorrhage was employed by placing iodoform gauze beneath the lip and a compression bandage on the outer portion. The adhesive strips with hooks were employed.

Fig. 901.—Angioma in an infant, occupying the buccal wall.

The compression bandage was allowed to remain for twenty-four hours. The external gauze was then removed. No hemorrhage occurred. In forty-eight hours the gauze in the mouth was removed. No hemorrhage followed. Fig. 990 illustrates the result.

Epithelioma.—An epithelioma is a tumor which is composed of epithelial cells. It may appear as a cutaneous horn, a flat ulcer or a wart-like growth. Carcinoma of the lip usually makes its appearance after middle life, *i.e.*, between the fortieth and sixtieth years. The tumor develops on the margin of the lip where the mucous membrane joins the skin. The usual site is close to the median line and it is seldom found at the corners of the mouth. Carcinoma of the lower lip is a rather frequent affection, found especially in

men (Figs. 902 and 903). Different authors quote statistics which show that the proportion found in men varies considerably in different localities. To illustrate, the following figures may be quoted:

König states the proportion to be	20 to 1 in favor of men
Lortet	7.6 to 1
Warren	19.25 to 1

The principal cause of carcinoma of the lip seems to be local irritation of some description. Among the irritations may be mentioned the constant rub of a pipe, cigar or cigarette holder, trauma caused by projecting teeth or

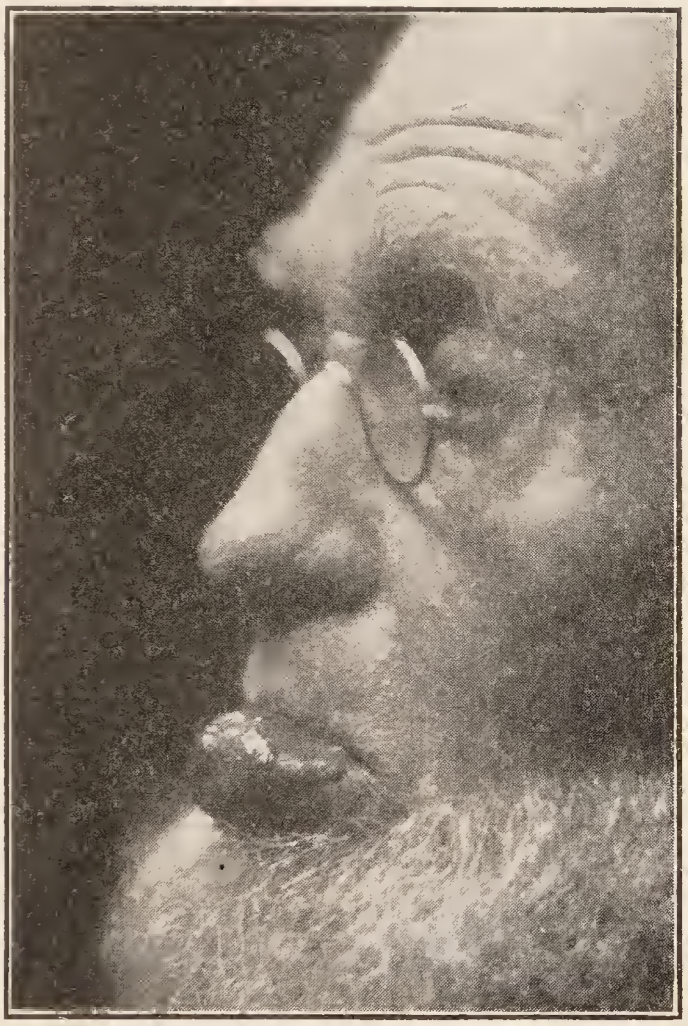


FIG. 902.—Epithelioma of the lip in a patient seventy-three years of age. The lesion started as a crack in the lip. The teeth were also in bad condition. (*J. F. Presnell.*)

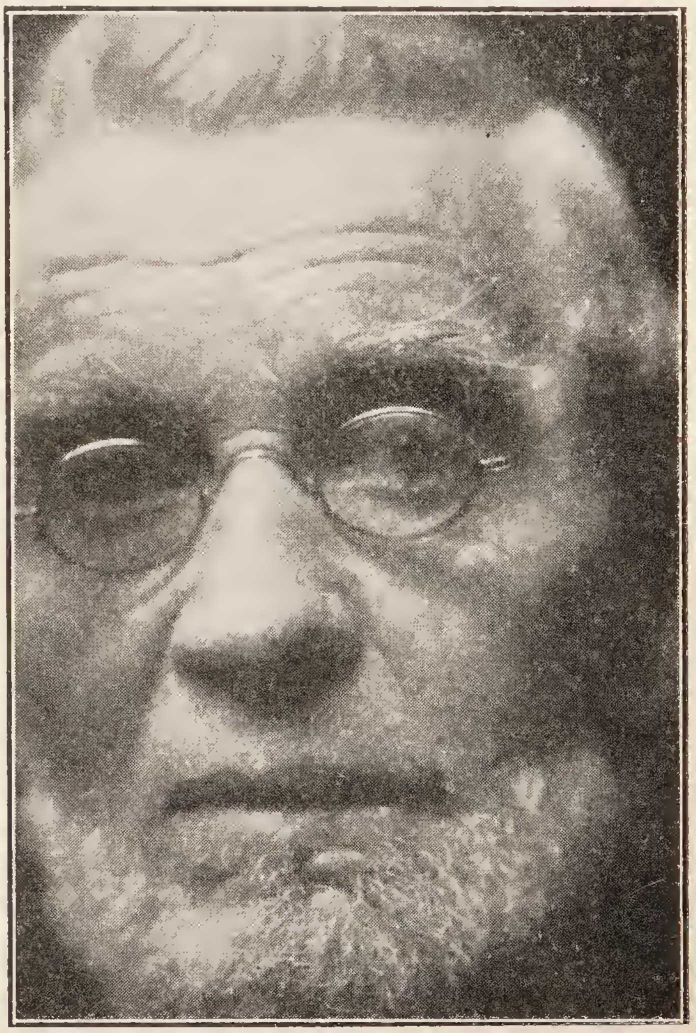


FIG. 903.—Same patient after operation. The patient lived for six years, when he died following a stroke of apoplexy. (*J. F. Presnell.*)

the irritation produced by a poorly fitting denture. In a recent article bearing on the subject, Bloodgood[1] states that there are several lesions which may appear on the lip and, if untreated, may result in a malignant growth. These he calls benign pre-cancerous lesions. "The most frequent benign, pre-cancerous lesion is a burn from smoking a pipe or a cigar. At the mucocutaneous border of the lower lip, there appears a small depressed area, dark in color and of leather consistency. This dark area cannot be picked off as a scab. Microscopically it is composed of dry, hornified epithelium, beneath which there is a zone of epidermis in which the capillary

[1] Carcinoma of the Lower Lip, Surg., Gyn. and Obst., XVIII, 1914, 404.

body is practically absent; nor do we see sweat-glands or hair-follicles . . . . I am impressed that in smokers' burns of this kind, the epidermis of the muco-cutaneous border is injured over a small area by a single or repeated application of heat. The probabilities are that the epidermal cells die, but do not become detached. This sequestrum of epidermis acts like a scab and new epithelium grows across. The dry, dead surface layer may remain intact for one year." In fifteen cases with benign lesions preceding the development of carcinoma, Bloodgood states that "Eight are distinctly smokers' burns; in seven there was a definite history of smoking, but the ulcer or wart developed in a fever blister in two cases and from wounds in five.

When the mucous membrane or epidermis of the skin is irritated or injured, there results either an ulcer or a hypertrophy of the epidermis. If the epidermis is entirely destroyed, there must first result an ulcer. If this remains unhealed, we have a chronic ulcer in which there is always an attempt at epidermization, or, in the healing of the ulcer, there may be an over-production of epithelium with the development of a wart, keratosis, corn, callosity or papilloma—all terms used to designate different gross types. These same lesions may develop at the point of injury without a primary ulceration.

So, in these benign lesions of the lower lip, there is always an etiological factor of some kind, due to either a single or repeated irritation. When perfect healing does not take place, there remains an epidermal defect of which the patient is conscious, although there is no pain. It is impossible to imagine a lesion on the muco-cutaneous border of the lower lip which, after it has developed, does not continue to be irritated, either by the pipe or the cigar which the patient continues to use, or biting with the teeth, picking with the fingers, or even irritation from coarser forms of food."

In his study of 185 cases of cancer, Bloodgood has never observed a microscopically malignant lesion in which the patient has not noticed a defect which, from the description, resembled one of the benign lesions above noted.

The tumor formation is occasionally preceded by a crack or fissure of the lip. As the disease progresses, it is noted that the apparently harmless lesion does not heal readily, but, on the contrary, continues to enlarge. This process may extend over several months and sometimes even years. It is noted that the base becomes more firm, which interferes with the lip functions. Soon the form changes and a small ulcer appears, which has an indurated base and margin. At this time it is common to find that the patients suffer more or less with pain. The glands in the neighborhood may also be enlarged. If allowed to continue, the ulceration may take on a more rapid growth and the patient will then show signs of cachexia. If still neglected, the mandible becomes involved, the adjacent tissue indurated and the process may extend to the floor of the mouth.

Treatment of Epithelioma of the Lip.—In the treatment of epithelioma of the lip, Bloodgood advises early and thorough operation. In his article he expresses his ideas thoroughly and I quote him here:

"The etiological factors should be sought for and immediately removed. The smoker must cease smoking; the individual who carries between his lips nails or other foreign irritating material should be instructed as to the danger and advised to discontinue the practice at once. The habit of biting the lower lip should be corrected and ragged or protruding teeth filed or extracted. Individuals who use tobacco in any form should be advised to discontinue it at once and be given a mouth-wash of bicarbonate of soda.

The little lesion should receive no irritating treatment, not even the mildest caustic. If there is an ulcer, it can be washed with a solution of bicarbonate of soda and covered with a non-irritating ointment. An emulsion of bismuth in castor oil or a two per cent. yellow oxide of mercury ointment has answered the purpose well in my experience. In extensive ulceration and fever blisters or chapping, I have had good results from covering the area with silver foil, as employed by Halsted for dressing wounds. This silver foil is kept in place by covering it with a little cotton fixed with collodion. Such a dressing will usually hold twenty-four hours. It should accomplish its result in a few days.

If the lesion is small, its radical local excision is not at all mutilating, and it is my opinion that such lesions should be excised if they do not heal in a week or ten days. In the more extensive lesions one is justified in waiting longer. In my experience all these cases have yielded immediately to treatment. I can see no justification of any delay in smokers' burns and in warts.

The excision of a local lesion should be done under local anesthesia. The needle should pierce the skin at some distance from the lesion. Direct infiltration of the zone of the disease itself is unnecessary and, in carcinoma, might be dangerous. To remove such lesions is a very simple affair. To give them a good margin never results in a mutilating scar. The part removed should be V-shaped and should include the entire thickness of the lower lip, both skin and mucous membrane. In closing, first pass the suture, threaded with a straight, intestinal needle, accurately through the mucocutaneous border. This keeps the red line of the lip in perfect approximation. Then the mucous membrane stitches are passed and the skin is sutured. The wound can be dressed with silver foil and fixed with collodion or adhesive straps. The post-operative discomfort is practicallp *nil* and the healing good when approximation is perfect.

When the lesion is near the angle of the mouth, the technic of excision and suture is a little more delicate.

The chief point to remember is never to restrict the local excision of the V-shaped piece within dangerous limits. *If in doubt, take a little more.* The margin of healthy tissue necessary to excise in lesions of the lip is narrow as compared with a lesion of similar size and type on the tongue. The submucous and subcutaneous tissue of the lower lip resist the local growth of cancers to a remarkable degree, while on the tongue the mucous membrane rests on muscle which is least resistant.

As a matter of fact, I have never observed a local recurrence in the hands of experienced surgeons, except in very extensive primary and recurrent carcinoma. In such cases the complete excision means a plastic operation to restore the lower lip. . . . These extensive lower lip operations are only necessary in the late cases, usually those which have received incomplete treatment. In this group it is my rule now to cut the lesion out with the electric cautery, giving the palpable zone of induration at least one cm. of margin; then the burnt area is cut out with the knife. No thought is given to the restoration of the lip until the local operation is finished.

The tissue excised at the local operation in the less extensive cases is studied microscopically and, if the disease proves to be a fully developed carcinoma, the gland operation is performed. Delay of a few days to a week in cases of this type has, as far as my experience goes, no element of danger.

In the more extensive cases, in which there is no doubt, clinically, as to carcinoma, the decision as to the operation upon the glands depends upon the local disease and the general condition of the patient. In these very extensive cases, the excision of the local area and tissue in the neck should be in continuity or *en bloc*, but in some cases the extent of the local operation, in view of the general condition of the patient, is enough for one sitting. One then burns with the cautery the tissue, passing from the local excised area into the neck, and, at a later date, performs the radical operation there."

Operation upon the Glands of the Neck.—"In the less extensive carcinoma of the lower lip, the extent of the operation upon the glands varies with the position of the lesion. When the carcinoma involves or crosses the midline, one should remove the entire mass of tissue from parotid to parotid, When the lesion is distinctly to the right or left, one removes the submental area and the glands beneath the jaw on the involved side. . . Of course, in very advanced cases of glandular involvement, the sterno-cleido-mastoid muscle should also be removed. But these late cases seem almost hopeless and, as yet, we have accomplished no cure. For the removal of the submental glands and those under one side of the jaw, one makes a curved incision, convex downwards, beginning below the lobe of the ear and extending to the jaw one cm. beyond the midline. This flap is dissected upwards, leaving the platysma muscle until the base of this flap is freed to the lower border of the jaw. Then an oblique incision is made downward on the neck from about the center of the convexity; the outer and lower flap is dissected until its base corresponds to the middle of the sterno-cleido-mastoid muscle. The inner and lower flap is dissected until the hyoid bone and fat over the sub-mental area are exposed. Now one separates this subcutaneous mass from the lower jaw, isolating and ligating the facial vessels first. In making the separation from the region of the symphysis of the jaw, I employ the cautery. Then one dissects this tissue from the masseter muscle down over the angle of the jaw until the tip of the parotid gland is exposed. Then the mass is dissected with a piece of the sterno-

cleido-mastoid muscle exposing the internal jugular vein. Here one exposes and ligates the large facial veins. Now the mass has only one attachment to the tip of the parotid. The dissection extends along the base of the median lower flap dividing the platysma muscle, the fascia of the deeper muscles, pushing everything up towards the submaxillary salivary gland. This tissue is quite vascular. We now have a pretty movable mass. Next, the internal jugular vein is exposed and ligated in the lower angle of the wound, divided between the ligatures, and lifted up with all the surrounding glands. The vein is again found beneath the mastoid process and again ligated. Then one cuts through the tip of the parotid gland. The only nerve divided in this dissection is a branch to the angle of the lower lip. This nerve cannot be saved without danger of leaving involved tissue. Now the mass is pulled downward and to the medial side and all the tissues beneath the parotid and around the piece of the internal jugular vein is dissected free, exposing the digastric muscle. The submaxillary salivary gland is enucleated and its deep vascular attachments, which pass through the muscles of the floor of the mouth, are clamped and tied. The mass has now only an attachment to the submental area. In making the dissection here, always take the fascia and some of the muscle. These sub-mental glands lie between the bellies of the genio- and myo-hyöid muscles and can be easily left behind if one does not dissect fascia and some muscle.

An incomplete operation upon the glands of the neck is really worse than no operation at all. To explore the neck to see if the glands are involved is a dangerous procedure. . . . . If the glands of the neck are not removed at the primary operation, there may be an interval of many years, up to seven, before the metastatic area gives evidence of its presence by enlargement of the lymph-glands. Operation at this late stage should be done, but the chances of a cure are remote."

Bloodgood states that he has determined that the two chief causes of failure to cure are late intervention and incomplete surgery for the stage of the disease when the patient presents himself.

"In the attempt to decrease the number of deaths from cancer, there are two factors over which we have control—the duration of the disease and the treatment. To decrease the duration we must educate the public and the profession on the potential dangers of the precancerous lesion. To improve treatment we must educate the profession as to the danger of irritating applications to the precancerous and early cancerous lesions, the danger of excision of a piece for diagnosis, and incomplete removal of the local disease. From a more critical study of a large group of cases we must educate the surgeons as to the proper operation, which varies according to the situation, character and duration of the lesion."

The large experience of Professor Bloodgood prompted me to quote him to such length. Early diagnosis and thorough removal of carcinoma in its incipiency afford the patient the most favorable outcome.

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